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US Army Information Systems Engineering Command  
Fort Huachuca, AZ 85613-5300

U.S. ARMY INSTITUTE FOR RESEARCH  
IN MANAGEMENT INFORMATION,  
COMMUNICATIONS, AND COMPUTER SCIENCES

# AIRMICS

## RESEARCH STATUS REPORTS

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Atlanta, GA 30332-0800



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**U. S. ARMY INSTITUTE FOR RESEARCH  
IN MANAGEMENT INFORMATION,  
COMMUNICATIONS, AND COMPUTER SCIENCES  
(AIRMICS)**

**RESEARCH STATUS REPORT**

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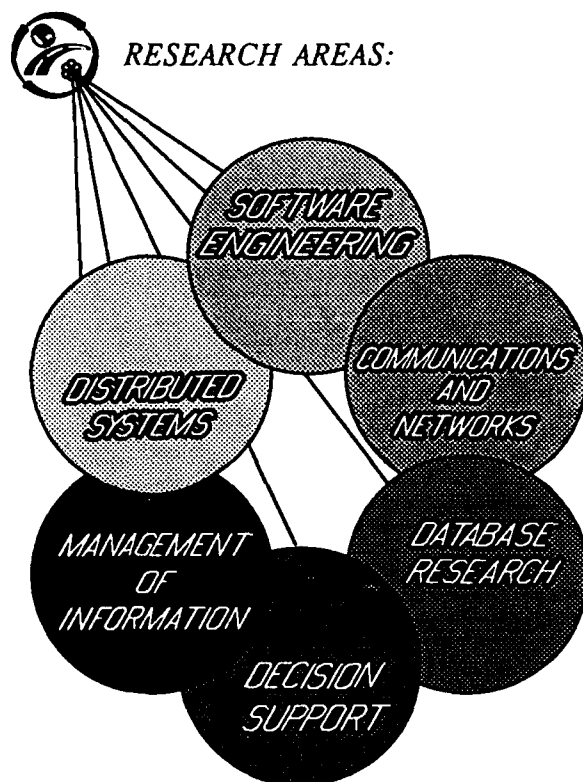
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## A. INTRODUCTION

This Research Status Report (RSR) summarizes ongoing research tasks, technology transfer efforts, and technical support activities performed by the US Army Institute for Research in Management Information, Communications, and Computer Sciences (AIRMICS) during the past year.

AIRMICS is subordinate to the US Army Information Systems Engineering Command (ISEC) and serves as the research arm of the US Army Information Systems Command (ISC). In consonance with this relationship, AIRMICS provides direct support to the ISEC technical staff, ISC headquarters and subordinate commands, and to Program Executive Officers (PEOs) and Project Managers (PMs) in the Information Mission Area (IMA).



Research in the IMA that AIRMICS both sponsors and conducts is important since in an era of increasingly tight budgets, meticulous attention must be paid to obtaining the largest return on the Army's investments. The rapidly changing, sophisticated high-technology areas are sources of particular scrutiny since funding must be concentrated on those developing technologies which have the greatest impact on enhancing the military's capabilities. In addition,

duplication of previous research must be avoided, and great care must be taken to avoid simultaneously funding multiple efforts which are similar in scope and goal.

Some of the research activities performed by AIRMICS include: literature searches; state-of-the-art studies; technology feasibility studies; technology assessments; and the planning, conducting, and evaluating of pilot projects. The first four of these activities are necessary prerequisites to the development of any system and are applicable to non-developmental item (NDI) acquisitions.

One benefit that ISC organizations can obtain from AIRMICS is the review of their advanced technology oriented contracts to determine technical merits of these efforts. When AIRMICS is consulted about subject matter within its research areas, it can review the proposed effort, identify what has already been done in regard to that effort, provide information on who may be working on that problem, and provide a value-added service by offering timely information on the current state-of-the-art in the particular technology area. This service is most valuable before contracts are awarded, so supported organizations can get the most leverage from their limited resources by contacting AIRMICS early.

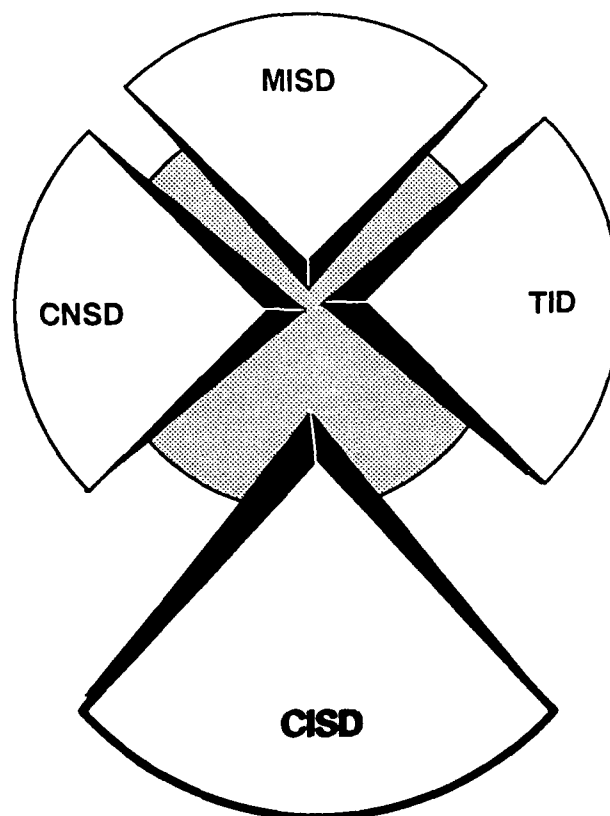
The mechanism for obtaining support from AIRMICS is straightforward. Simply submit a request either in writing or via electronic mail to the Director of AIRMICS. Then, AIRMICS will evaluate the request. Requests for technical support, analytic services, and related actions will be done as in-house resources permit. Requests for projects requiring contractual support will be evaluated and entered into the ISC Research, Development, Test, and Evaluation (RDTE) Five Year Program Plan, if appropriate. These requests will be assessed for action based on the nature of the effort and the availability of funds. If funds are sent along with the request, after favorable evaluation, the effort can be placed under contract within two weeks to four months (depending on the nature of the research effort).

Four functional divisions comprise AIRMICS — Management Information Systems Division (MISD); Computer and Information Systems Division (CISD); Communications and Network Systems Division (CNSD); and Technology Insertion Division (TID) — each of these divisions is responsible for several research areas. Sections B, C, D and E are organized to provide information about the ongoing research tasks at AIRMICS by division and research area. Finally, sections F and G list AIRMICS upcoming events and points of contact within AIRMICS.

## **B. COMPUTER AND INFORMATION SYSTEMS DIVISION (CISD)**

CISD performs research in the areas of Software Engineering and Very Large Database Systems.

In the Software Engineering area, CISD works to reduce software life cycle costs, increase the productivity of software development and support organizations, and increase the quality of the components, systems, and products delivered. CISD conducts research in software quality and productivity measurements, software requirements, software reusability, software maintenance, management of software development, Ada transition, and modernization of the Army's installed base of application programs.



In the Very Large Database area, CISD works to develop the capability to effectively design, implement, operate, and manage large heterogeneous geographically dispersed databases. CISD investigates methods, practices, and tools to aid in this endeavor.

CISD conducted several projects in the software engineering area and one large project - ANSWER - in the database area.

The Ada transition task is a joint AIRMICS-SDC Atlanta effort to look at the process of moving an existing STAMIS (Standard Army Management Information System) written in COBOL to Ada. We specifically address the topics of reverse engineering, object-oriented design versus functional decomposition design, and the use of CASE tools.

The Ada Reuse project closed with all work completed in December. Tasks performed in this effort looked at metrics for Ada reuse, incentives for reuse, reuse-oriented cost modeling, and an assessment of software engineering tools. We held the last IPR for this project at Fort Belvoir in September and produced a guidelines document for reuse and metrics early this year.

CISD also executed, under the sponsorship of ISSC (TSD), a short-term task to harmonize the products from DOD-STD-2167A (Defense Systems Software Development) and DOD-STD-7935A (DOD Automated Information Systems Documentation Standard). We produced a guidelines document that takes advantage of the software engineering and management approaches embodied in 2167A while maintaining the use of documentation items associated with DOD-STD-7935A. We delivered the draft report in December and the final version in May. Copies have been sent to ISSC and ISEC.

CISD provided support to the PEO/PM structure. COL Byrd, PM Installation Support Modules (ISM), visited AIRMICS for discussions and a CISD representative participated in the October 1989 matrix support IPR hosted by PM ISM at Fort Belvoir to gather information on the type of support AIRMICS could provide based on the issues discussed at the IPR. CISD representatives have also participated in several of COL Byrd's workshops that focused on the Installation Integrated Database. ANSWER (see discussion on database effort) is being considered for possible use in their prototype system.

CISD provided input to the DOD Software Master Plan. This document was prepared by the Defense Acquisition Board Science and Technology Committee Software Technology Working Group, with input from DOD elements. The working group produced a DOD-wide plan to define a program for DOD to provide increasing capabilities for emerging and existing systems, while reducing the costs and logistics burden associated with development and life cycle maintenance of software. The plan is being

staffed through DOD. As a follow-on effort, a DOD Software Technology Plan is being prepared and CISD is participating in this effort.

A task to evaluate the Distributed Computing Design System (DCDS) to determine its appropriateness in meeting the requirements of a software support environment for the MIS community is being conducted by Purdue University. DISC4 sponsored this task and the first IPR was held at AIRMICS in November. TRW in Huntsville developed DCDS for the Strategic Defense Command and DCDS specifically supports large, complex, real-time distributed systems.

DISC4 also funded the development of a method to determine the quality of software products and the effectiveness of software development and support organizations. The Center for Information Management Research (Georgia Institute of Technology and the University of Arizona) conducts this effort. The results will be used to improve the management of both software development and software support and reduce the need for frequent modifications and corrections to fielded software systems.

In September 1990, AIRMICS initiated development of a method to predict software reliability in the operational phase of a system and to determine operational readiness at major reviews. The expectation is a prototype tool which implements this new method. The Operational Test and Evaluation Agency (OTEA) funded this work and Syracuse University is performing the research.

AIRMICS is also participating in the Small Business Innovation Research (SBIR) Program. CISD is having a Phase I study being performed by STATISTICA, Inc. to define one or more Ada Programming Support Environments (APSE) based on the development, enhancement, and maintenance characteristics of Management Information Systems (MIS).

CISD works with two research centers: The Software Engineering Institute (SEI) of which we are an affiliate member representing ISEC, and the National Science Foundation's Software Engineering Research Center (SERC) located at Purdue University and the University of Florida. The SERC Industrial Advisory Board meetings were held in November 1989 at the University of Florida and in May 1990 at Purdue University. The SEI annual affiliates conference was held in September 1990.

A final note in the software engineering area, CISD also participated in the Requirements Engineering and Rapid Prototyping Workshop held at CECOM in November 1989.

In the database area, the ANSWER (Army's Non-Programmer System for Working Encyclopedia Requests) project progressed with an IPR for Phase 2 conducted at AIRMICS on 13 December 1989. Representatives from DISC4, ISEC-SID, ISSC-DMD, Mitre, and PRC attended. ANSWER will function as an encyclopedic facility by allowing users to access, query, register, and remove databases from the encyclopedia's catalog. ANSWER includes a data management toolset integrated under X-Windows, an AI-based standard data element naming tool, and an Information Resource Dictionary System (IRDS) component. In September, CISD held an IPR at Fort Lee for Phase 3A in conjunction with COL Byrd's workshop on the Installation Integrated Database. Representatives from many different commands attended. The two main functions demonstrated were a query formulation tool and two distributed query processing algorithms.

If you are interested in any of the above areas discussed in this Research Status Report, or have questions relating to CISD, please contact Mr. Glenn Racine, e-mail address [racine%airmics@gatech.edu](mailto:racine%airmics@gatech.edu), phone (404) 894-3110.

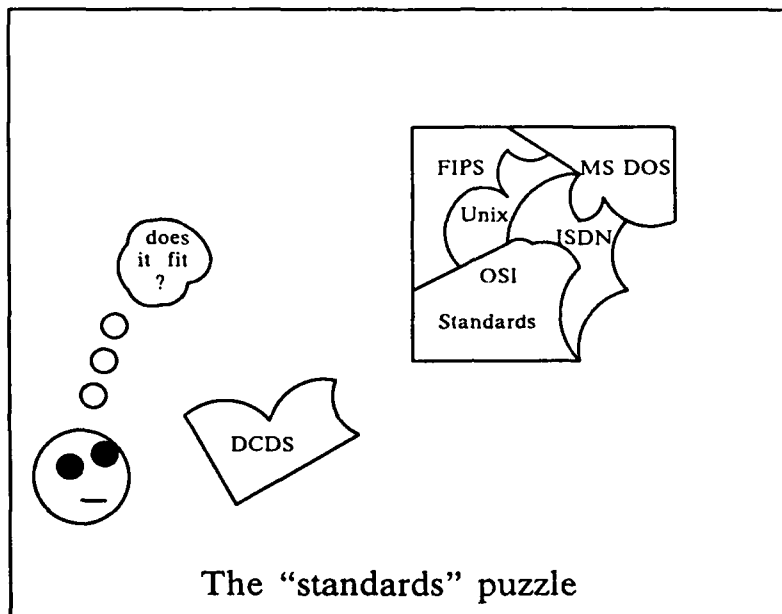
## 1. SOFTWARE ENGINEERING RESEARCH

### a. TITLE: Evaluation of the Distributed Computing Design System

POC: Mr. Butch Higley; (404) 894-3110

CONTRACTOR: SERC (Purdue University), Dr. Dunsmore

OBJECTIVE: To evaluate the Distributed Computing Design System (DCDS), for meeting the information requirements of a software engineering support environment.



BASIS: A number of Army Audit Agency (AAA) and Inspector General (IG) reports have identified significant problems in Army software quality and software support. One approach to solving some of these problems is to focus on a single software development environment for the entire Army, suitably tailored for application to differing needs. Already in existence is the DCDS which is public domain and supported by TRW under contract to the Strategic Defense Command. It has been proposed as the Army standard Ada Program Support Environment by DISC4. There is not yet a consensus definition of the information requirements for a programming support environment within the Army nor the DOD or the industry at large. There have, however, been efforts which will contribute to an evaluation of a programming support environment:

MIT has done a study identifying information that CASE tools should collect for the development of a software application system. (Dimensions of I/S

Planning and Design Technology; Henderson, John C. and Coopriders, Jay G.; Center for Information Systems Research; MIT Sloan School of Management; September 1988.) Evaluation of DCDS with respect to information systems should start from this foundation.

The Software Engineering Research Center sponsored by the NSF has been evaluating information requirements of the more popular CASE tools. Methods used in these evaluations should provide a good beginning to the evaluation of DCDS. A second point of departure is to compare the information collected while using DCDS to the information collected using the five most popular CASE tools.

The Software Engineering Institute has developed a method for assessing the state of software engineering practice within a software development organization and for evaluating the software engineering support characteristics of software contractors. This technique is being incorporated into a separate program and is being folded into other methodologies.

**APPROACH:** Using a combination of these approaches, the effort will be an assessment of the applicability of DCDS to support sustaining base software. To this end, the following tasks have been selected:

1. The first task is to identify the combined information needs of the five CASE tools with the greatest market share (and which cover the greatest portion of the life cycle) and to combine these into a single expression of data needs. These data needs should be placed in the context of the MIT report with comparable data elements. Included should be a data element name, a description of the data collected (including code values and their definitions if applicable) and the CASE tool(s) which collect that information.
2. The second task is to identify the information needs indicated by the Software Engineering Institute evaluation questionnaire as being required from the Software Engineering Support Environment.
3. The third task is to identify the information collected when using DCDS and to compare these results with those needs derived from tasks 1 and 2.
4. The fourth task is to compare the results of tasks 1, 2, and 3 to determine how fully DCDS collects information suggested as needed by the MIT report, by the collected CASE tools and by the SEI assessment questionnaire. This comparison should also identify information DCDS causes to be collected which is beyond the scope of that called for by the MIT report and collected

when using the CASE tools. An evaluation of the strengths and weaknesses against the needs of information system software support should be done. Any obvious missing information from both the selected CASE tools and DCDS should also be identified.

5. The fifth task is to compare performance and resource aspects of DCDS with respect to the CASE tools. Specifically needed is an assessment of the ease of use, the expertise required to use the tools, the training required to obtain that expertise, the hardware/software environmental requirements (what hardware platforms, what operating system, what supplemental software is required, etc.), the available licensing arrangements (CPU license, site license, Army-wide license, etc.), the costs to maintain, and the sustaining support arrangements (are they market oriented or subject to funding limitations).

6. The sixth task is to provide conclusions on the suitability of DCDS as an Army-wide standard Ada Programming Support Environment. DCDS should be compared and contrasted with the CASE tools and a trade off analysis showing whether other tools would be more suitable. The conclusions should also identify the Army environments in which DCDS is most suited and the tailoring possibilities for small, medium, large, and extra large application systems development. Included with such conclusions should be a list of recommended changes to DCDS which:

- Eliminate deficiencies in needed functions in general
- Enhance DCDS support for software development and maintenance for the management information system (MIS) software
- Do not detract significantly from support for embedded systems.

**ACCOMPLISHMENTS:** The first two tasks have been addressed in separate reports — Technical Reports 3.1 and 3.2 — and were completed by July 1990. Tasks 3 and 4, also technical reports, are in draft form. During the August meeting of the Software Technology for Adaptable, Reliable Systems (STARS) Technical Interchange Meeting (TIM) and Program Management Review (PMR), the preliminary results of this research were briefed and the technical reports available to that date were distributed.

**PLANS FOR NEXT QUARTER:** The project is nearing completion. All technical reports should be completed and available upon request. The current plan is to provide a full scale brief on the entire project's results at the next STARS TIM & PMR.

## PUBLISHED REPORTS:

1. Varnau, S., Dunsmore, H.; "Software Development Information Supported by Typical CASE Tools", Technical Report 3.1, SERC-TR-77-P, July 1990.

In this study, the researchers considered the information collected by a CASE tool as its most important feature. The effort was to identify data collection requirements for a fully flexible CASE environment and to compile a preliminary list of information needs. The results were compared to the information collected in five existing products and desirable functionality as suggested by Henderson and Coopriders.

2. Varnau, S., Dunsmore, H.; "Software Development Information Supported by the SEI Contractor Assessment Questionnaire", Technical Report 3.2, SERC-TR-78-P, July 1990.

The Software Engineering Institute (SEI) Technical Report CMU/SEI-87-TR-23 (Fall, 1987) was examined. Written by Watts Humphrey and William Sweet, "A Method for Assessing the Software Engineering Capability of Contractors" details questions and procedures to be used in considering potential DoD contractors. Humphrey and Sweet designed a questionnaire to assess objectively the capabilities of contractors to use modern software engineering techniques in product development. A comparison was made to the data requirements collected and the data requirements suggested by the SEI questionnaire.

3. Varnau, S., Dunsmore, H.; "Software Development Information Supported by the Distributed Computing Design System (DCDS)", Technical Report 3.3, Draft Copy, July 1990.

The Distributed Computing Design System (DCDS) is examined and evaluated according to data collection requirements for CASE systems that were previously developed from an earlier task of this project. The data collection requirements should categorize and define what information a standard CASE environment needs to collect.

4. Varnau, S., Dunsmore, H.; "Software Development Information Completeness in the Distributed Computing Design System (DCDS)", Technical Report 3.4, Draft Copy, August 1990.

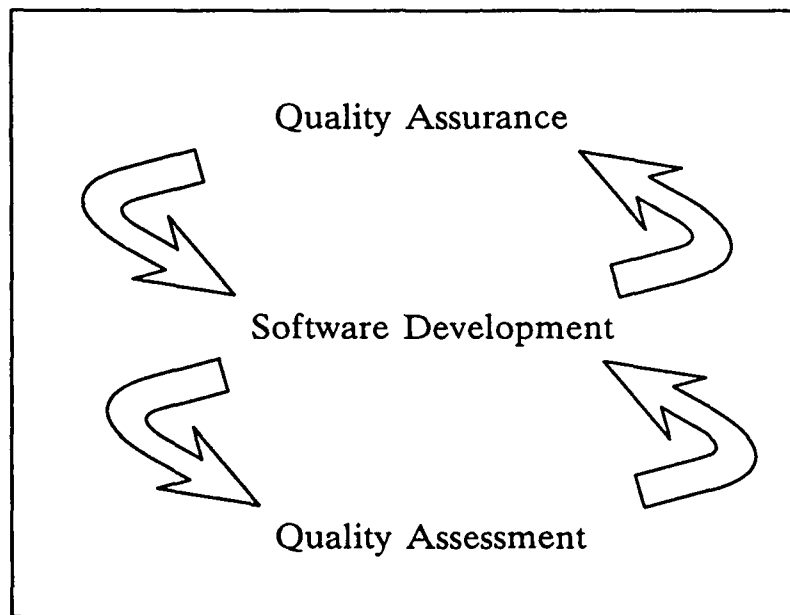
The implications of the three previous tasks of this project were explored with respect to the evaluation of DCDS. This was done in accordance to the data collection requirements. The evaluation should provide insight into basic support functionality as well as data collected.

**b. TITLE: Software Support Qualitative Assessment Method**

POC: Mr. Butch Higley; (404) 894-3110

CONTRACTOR: CIMR (Georgia Institute of Technology and the University of Arizona)

OBJECTIVE: This project will develop and test a "Software Support Qualitative Assessment Methodology." This effort will include review and evaluation of software support organizations in AMC, ISC, HSC, and the COE. The major focus of the study will be the development and documentation of a method for developing a qualitative assessment of software support organizations and software products (software metrics). This study will also provide a qualitative assessment of designated organizations and products using the proposed methodology.



BASIS: A number of Army Audit Agency (AAA) and Inspector General (IG) reports have identified significant problems in Army software quality and software support. There is currently no method of determining the effectiveness of software support for Army requirements although the SEI with CECOM support has started work in this area. The level of support provided by a software support organization and user satisfaction with that support is as important as the quality of the software products produced for

purposes of management decision making and planning. The only criteria available to Army management at this time are reports of failures. There must be a method developed to provide management information on organization and product performance prior to disaster in order to avoid these crises. A more expanded statement of the problem exists in the proceedings of the Third information Science and Technology Assessment for Research (ISTAR) Conference (April 1987).

Software is a critical element in Army operations on and off the battlefield. Effective use of software can act as a force multiplier through enhancing weapon performance, command and control activities, and sustaining base software. Obviously, defective software can have an extremely negative impact, not only on fielding of new systems, but in operations and survivability. Without a method of determining software quality, systems failures will continue to occur with little or no warning and corrective measures will remain reactive, addressing only the defect that resulted in that particular failure. Management of software support organizations will be done as in the past with no management control over effectiveness.

The ability to determine the quality of software products prior to operations will reduce the quantity of modifications and change requests submitted during the production and fielding phases of a weapon system or other information processing system. Use of this methodology throughout the system life will assist in the development of effective software as quickly as possible by identifying problems early, before they impact the program. With the ability to assess the effectiveness of a software support organization, corrective action can be taken to address structural problems as well as technical difficulties.

AIRMICS and the Air Force Rome Air Development Center have developed software metrics for the evaluation of software during development. Selection of a representative set of these metrics is a possible point of departure for determining the quality of software products prior to operations.

The Software Engineering Institute has developed a method for assessing the state of software engineering practice within a software development organization and for evaluating the software engineering support characteristics of software contractors. Use of this method is a possible point of departure for determining the relative use of the state of the art in software engineering in the respective software support organizations.

There remains another dimension of software support evaluation that has not been touched by known prior work in software metrics or by the software engineering assessment methodology. Both of these are methods which deal with the quality of software either internally (as code or documentation) or with the internal comparison of the organization to known "good" techniques. The remaining dimension is the external view of the quality of support by the using organization. With respect to other significant acquired items, the Army uses a readiness profile to describe the state of a unit and its readiness to fight a battle. In this process, various items of equipment are compared to known standards and classified green, yellow, or red. (Green meaning fully ready to fight a battle, yellow meaning ready to fight but with some limiting condition which detracts from the unit's ability to fight, and red meaning incapable of being used to fight a specific battle.) Extension of this method of evaluation would provide a summary external to the software support organizations of the effectiveness of software support for Army requirements.

**APPROACH:** AIRMICS has been asked by DISC4 to explore and unify these approaches to assessing software support and to provide a management perspective of software support organizations in meeting the needs of the Army for software. The execution of this effort has been broken down by the following eight tasks:

1. The first task is to review the currently available commercial metric tools and the current research work in software metrics and select a limited set of metrics which would provide a view of a software product during the development phase so that operations and maintenance is given more consideration during development resulting in reducing unit costs of software support during the operational phase.
2. The second task is to take the results of the SEI/CECOM effort to apply the assessment process to Army organizations instead of to contractors and to review it for applicability of comparing the status of the widely varying organizations within the Army. If the results of the SEI/CECOM task are not timely, then the SEI contractor assessment process as it stands will be reviewed to see if it can be applied to provide an effective audit of the software engineering capability of Army software support organizations while maintaining the comparability of the instrument to the software support industry at large. This task should also take into consideration all applicable software policies.

3. The third task is to use the refined process to conduct trial assessments of at least one software support organization from each of AMC (MIS support, not embedded), ISC, HSC, and the COE and to take the results of SEI conducted assessments for CECOM to ascertain the appropriateness of the technique as a whole and to provide an initial comparison of the respective capacities of the organizations. As software development agencies, contractors may be included in this task for a second or other additional project from any one of the above organizations, if necessary.

4. The fourth task is to collect an inventory of software systems and software support organizations responsible for those systems from AMC (both embedded weapons systems and MIS), ISC, HSC, and the COE. This inventory will be used to provide an initial view of the effectiveness of the organizations in using their resources in support of the Army. Included in the inventory should be a list of the using organizations for each software system. The resources used by the organization as a whole will also be collected so that can be compared as well. [Inventories are known to exist at AMC and ISC. These will be used and augmented as necessary. It is not known whether they will be adequate for this effort and hence could be more effort than is desired for this project.]

5. The fifth task is to select one or more representative systems each from AMC, ISC, HSC, and the COE and develop a profile showing the number of locations at which each system operates, the current outstanding reported problems, the aging of the current outstanding reported problems, the outstanding backlog of requests for system modification, classified as to reason for the request (regulatory, improve system effectiveness, and system capability, improve system performance, and other), and aged, the resources devoted to supporting the selected systems, and the estimated resources required to complete and install the changes from the outstanding problem reports and system modification requests. The purpose of this task is to provide a basis of reality to the sixth task so that the resulting standard and method will be based on current data.

6. The sixth task is to develop standards and methods for classifying software systems and their current condition at the operational sites according to appropriate definitions of green, yellow, and red or to show why such a standard would not be appropriate. These standards and methods could involve reporting from organizations using the systems in addition to reports from software support organizations. [The information from tasks four and

five are expected to be necessary in the development of this approach to classifying the support characteristics of Army systems.]

7. The seventh task is to identify how the metrics, standards, and methods from tasks one through six could be collected and reported on a routine basis, the organizational changes required to support the approach, an estimate of the one-time costs of implementing the procedure, and an estimate of the continuing costs of using the process.

8. The eighth task shall estimate the quantitative benefits of the approach in reducing the cost of software support, improving the readiness of Army software systems, in improving the readiness of software systems, and in providing visibility of the state of the software systems and software support organizations to management.

ACCOMPLISHMENTS: The Corps of Engineers has been dropped from the evaluation process and has been replaced by Forces Command (FORSCOM). Interviews have been performed and questionnaires completed by AMC, HSC and FORSCOM.

PLANS FOR THE NEXT QUARTER: The focus at this point in the project is to select a particular command and concentrate our efforts on gathering extensive details, and based on the interviews and questionnaires, extrapolate findings.

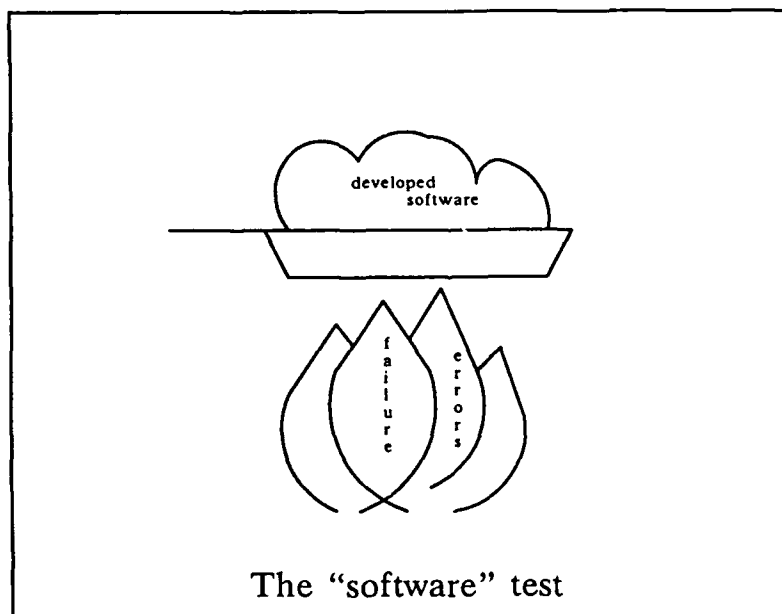
**c. TITLE: Software Test Readiness Monitoring and Prediction Method**

POC: Mr. Butch Higley; (404) 894-3110

CONTRACTOR: Syracuse University, Dr. Amrit Goel

**OBJECTIVE:** To develop an analytical method for monitoring test progress and determining software readiness for operational testing. Towards this goal, models will be developed based on a non-homogeneous Poisson process (NHPP) and the proportional hazard function. A detailed study of the relevant metrics for use in this effort will be undertaken. Use of empirically based classification trees as metrics integration frameworks will also be investigated.

**BASIS:** An important problem of concern to the U.S. Army and the Operational Test and Evaluation Agency (OTEA), in particular, is to determine when a software system is going to be ready for operational testing. There is a need for an analytical method to monitor testing progress and to predict software test readiness.



**APPROACH:** The main thrust of the first phase — monitoring and forecasting software readiness — is to develop an analytical model for assessing and predicting software maturity levels. The developed model could then be employed to determine the time at which desired maturity levels will be attained. In order to develop the model, an investigation will be required

into various software metrics and measures. Examples would be: function points, designed base and code base metrics and measures, and density for various error types. A judiciously chosen subset of such metrics will be used as the core of the monitoring and forecasting method. Also within the first phase, an investigation will be conducted into the use of empirically based classification trees as a metric integration framework.

The modeling techniques to be explored will be the proportional hazard model, Poisson and non-homogeneous Poisson process and time series models. By applying these models at various points in the system development life cycle, the user will be able to get an analytical assessment of the current status of software vis-a-vis the target quality. Also, these models will be used to determine when the system can be expected to meet the test readiness goal. The information could prove to be useful in determining any corrective actions that should be taken (e.g., accelerated testing, increase in testing personnel, etc.) to meet the readiness objectives.

The second phase will be the evaluation of on-going projects. Along with the development of the monitoring and forecasting method, testing the method will be accomplished. Various on-going projects will have their relevant data analyzed and evaluated using the method. Such analyses will serve two important objectives: (1) ensure the relevance of the method and (2) provide useful information about the projects.

**ACCOMPLISHMENTS:** The project has just been started, and is scheduled for completion in February 1991. The initial IPR took place in late September 1990.

**PLANS FOR NEXT QUARTER:** Phase one of the project will be initiated as discussed above.

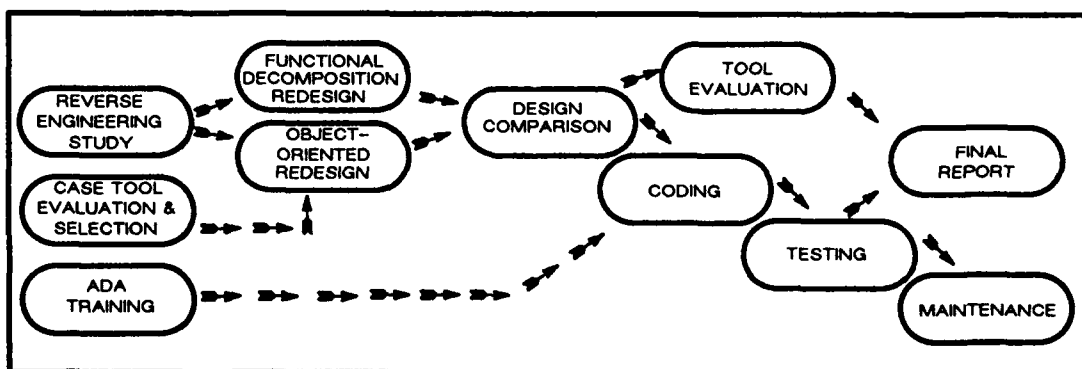
**d. TITLE: COBOL to Ada Transition Project**

POC: Reginald Hobbs; (404) 894-3110

CONTRACTOR: In-house

**OBJECTIVE:** The objective of this project is to examine the use of various tools and methodologies in transitioning existing applications from batch-oriented COBOL systems utilizing flat files to interactive systems written in Ada. Specifically, this project will examine the application of reverse engineering tools and methods, compare functional decomposition versus object-oriented design, evaluate the use of CASE tools for systems analysis and design, assess Ada training provided by the Army, and examine the maintainability of code designed using currently available tools.

**BASIS:** The U.S. Army Information Systems Engineering Command (USAISEC) currently maintains over 100 Standard Army Management Information Systems (STAMIS). With the advent of Ada, one of the options available is to transition these systems from a COBOL, flat file, batch processing mode to systems written in Ada with increased functionality, maintainability, and reusability. While the appropriate technology exists for this effort, no systematic knowledge exists about how to effectively and efficiently make the transition. This lack of knowledge hinders the development of an appropriate transition strategy.



**APPROACH:** In conjunction with personnel from Software Development Center-Atlanta (SDC-A), the Installation Material Condition Status Reporting System (IMCSRS) will be reengineered, redesigned, coded, tested, and implemented in Ada by AIRMICS. IMCSRS is an operational STAMIS currently written in COBOL. The more substantial tasks to be completed include: evaluation of software reengineering/restructuring and CASE tools;

reengineering of IMCSRS to create a high level description of functionality; redesign of the system using object-oriented and functional decomposition methods; analysis/comparison of design approaches; coding and testing. A final report outlining reverse engineering and redesign strategies for STAMIS will be prepared as well as significant findings of the actual transition process.

**ACCOMPLISHMENTS:** A task order was initiated with Dr. Rugaber of the Software Engineering Research Center (SERC) at the Georgia Institute of Technology. He developed a high level requirements definition of the IMCSRS system along with reengineering and redesign strategies for STAMIS-like systems.

SDC-A provided Ada training to two of their programmers. The evaluation, selection, and procurement of required hardware was accomplished. A SUN platform was provided by AIRMICS to SDC-A for familiarization in preparation for design and coding activities.

AIRMICS selected the Cadre Technologies CASE tool suite and utilized their tools in the redesign effort. The tools support both object oriented and functional decomposition design methods as well as the generation of template Ada code and support for DOD STD 2167A documentation. CASE training and familiarization has been completed.

Analysis, reengineering, post-analysis, and development of new requirements for the IMCSRS STAMIS were conducted jointly between SDC-A and AIRMICS. Major David Stevens of AIRMICS and Captain Rich Wassmuth of SDC-A attended formalized Ada training at Fort Belvoir, VA in order to evaluate how well Army training methods mapped to programmer/developer needs. Two separate system designs (object-oriented and functional decomposition) were undertaken simultaneously in order to assess the relative merits of the methodologies in this type of transition effort.

**PLANS FOR NEXT QUARTER:** Using the results from the design effort, personnel from SDC-A will code the IMCSRS system using Ada. There are also plans to implement the new design for IMCSRS using relational database technology in support of a separate AIRMICS project concerning open systems architecture.

PUBLISHED REPORTS:

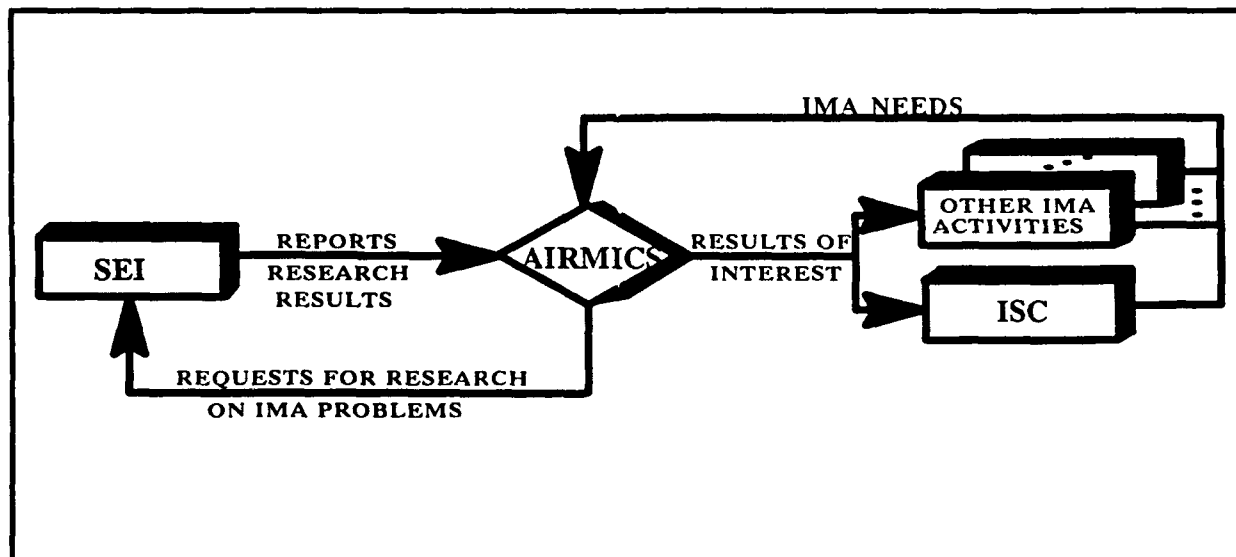
1. Hobbs, R. L., Nealon, J., and Wassmuth, R., "Ada Transition Research Project—Final Report," DY10-02-04-03, AIRMICS, Computer and Information Systems Division (CISD), October 1990.
2. Rugaber, S., Kamper, K., "Design Decision Analysis Research Project—Final Report", GIT-SERC-90/01, Georgia Institute of Technology, Software Engineering Research Center, January 1990.

e. **TITLE:** Software Engineering Institute (SEI) Coordination Activities

**POC:** Mr. Glenn Racine; (404) 894-3110

**CONTRACTOR:** Software Engineering Institute/Carnegie Mellon University

**OBJECTIVE:** The SEI promotes the evolution of software engineering from an ad hoc, labor intensive activity to a managed, technology-supported discipline. The objective of the SEI is to bring the ablest professional minds and the most effective technology to bear on rapid improvement of operational software in mission-critical computer systems, to accelerate the adoption of modern software engineering techniques and methods, to promote use of modern techniques and methods throughout the mission-critical systems community, and to establish standards of excellence for software engineering practice.



**BASIS:** Representatives from the services identified a need to reduce the time it takes to inject new technologies into DOD and DOD contractors' standard practices. The establishment of the SEI is a result. AIRMICS is a government affiliate of the SEI and monitors the work done by the SEI in order for ISC and ISEC to take advantage of that work.

**APPROACH:** The SEI has developed a staff (154 personnel) and has obtained more than 270 affiliate agreements with corporations, approximately 53 different universities, and 21 government agencies. This provides both sources for new public domain technology and target organizations which can benefit from use of software engineering technology. As an affiliate, AIRMICS acts as the focal point to transfer pertinent SEI results into the

ISC/ISEC community. This includes everything from summarizing reports to taking advantage of services offered by the SEI.

**ACCOMPLISHMENTS:** The ongoing SEI efforts encompass a broad range of software engineering activities. The current programs (highest level efforts) include: Software Engineering Process, Software Engineering Methods/Tools, Software Systems (real-time, distributed), Software Engineering Education, Technology Transition, Risk Program, and Ada/STARS Support.

The SEI has developed a maturity level/key issues matrix which is a rating scheme showing how an organization employs software engineering concepts and principles in software development efforts. This matrix has been used by the SEI in preparing an assessment questionnaire to help determine the state of the software engineering process within a given organization. An assessment team is formed and it uses the questionnaire to evaluate an organization and provide an assessment of its adherence to software engineering practices and principles. If applicable, a recommended approach to improving the software engineering expertise is provided. AIRMICS is bringing this evaluation process into the ISC/ISEC community. A team of people composed of representatives of the Software Development Centers, ISSC Headquarters, and AIRMICS received training in making an organizational self-assessment on 19-22 September 1989. That team has conducted self-assessments of all but one of ISEC-ISSC's System Development Centers. The team is coming up with a set of findings as a result of the assessments.

The SEI also provides a three day course on change management. The purpose of this course is to enable managers to accommodate technological change with the least possible disruption. This course can be given to ISEC personnel in ISEC facilities. The charge is \$200 per person for materials. The maximum number of students in a given course is 25, and it is oriented to management personnel. A minimum lead time of one month is required; a more comfortable lead time would be three months.

The SEI has prepared a curriculum guide for a Masters of Software Engineering within the Software Engineering Education program. University affiliates are invited to prepare video tapes on courses listed in the guide. These tapes are sent to universities with limited software engineering courses and are offered as courses at these smaller schools. Army sites with local

universities could take advantage of this program. George Mason University is a current SEI affiliate and SDC-W personnel can take these courses through that facility. There are about forty SEI academic affiliates where these courses can be offered. The SEI is also looking for additional academic affiliates, so even if a college or university near an ISEC site is not an affiliate, affiliation can be obtained.

AIRMICS obtains many of the SEI reports and announces their availability through this report. The reports listed below can be obtained by contacting AIRMICS. In addition, AIRMICS is representing ISC and ISEC at the Joint Advisory Committee Executive Group Technical Reviews and attended the annual SEI Affiliates Symposium in September. Other members of ISC and ISEC desiring to attend the Affiliates Symposium or participate in other activities of the SEI should contact AIRMICS if they need help in making appropriate contacts.

**PLANS FOR NEXT QUARTER:** AIRMICS is developing plans to take some SEI results and proposed plans and share them with interested managers and software developers throughout ISC and ISEC.

**PUBLISHED REPORTS:**

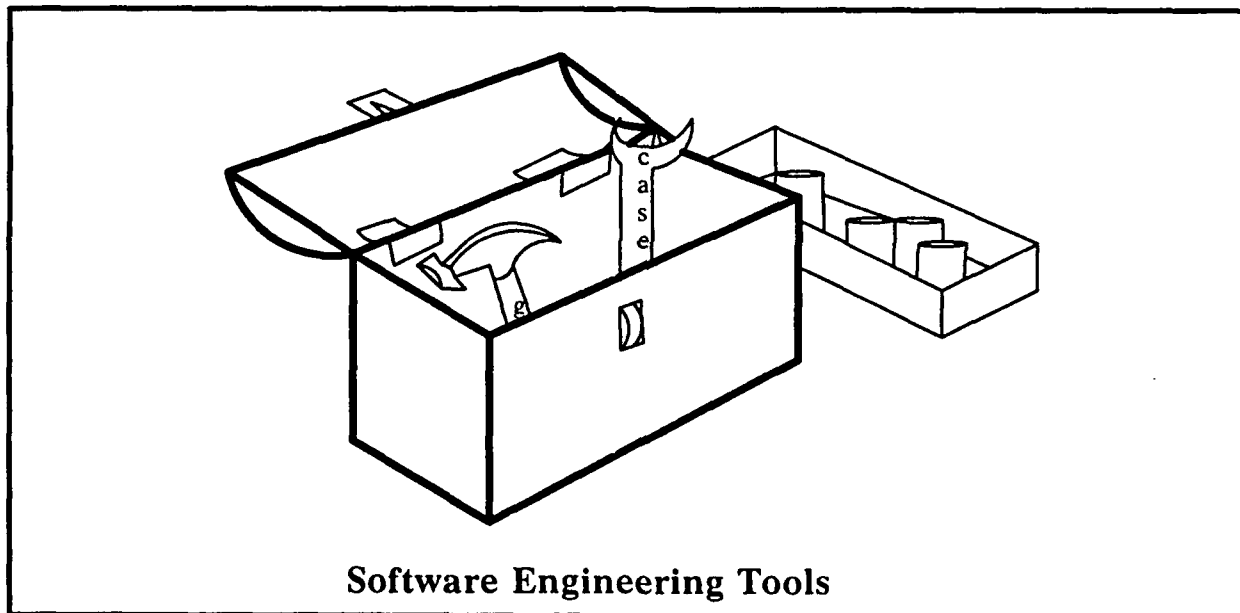
1. Shaw, Mary; "Prospects for an Engineering Discipline of Software," CMU/SEI-90-TR-20, September 1990.
2. Ford, Gary; "1990 SEI Report on Undergraduate Software Engineering Education," CMU/SEI-90-TR-3, March 1990.
3. Donohoe, P., Shapiro, R., Weideman, N.; "Hartstone Benchmark User's Guide, Version 1.0," CMU/SEI-90-UG-1, March 1990.
4. Borger, Mark W., Klein, Mark H., Veltre, Robert A.; "Real-Time Software Engineering in Ada: Observations and Guidelines," CMU/SEI-89-TR-22, ESD-TR-89-30, September 1989.

**f. TITLE: Assessment and Development of Software Engineering Tools**

POC: Mr. Butch Higley; (404) 894-3110

CONTRACTOR: Georgia State University; Dr. Ross A. Gagliano

OBJECTIVE: In software engineering, tools have been identified as the primary means by which better, concise, and more productive software products can be produced. To this end, numerous tools have been brought to market, all proclaiming to be the best for their particular function. The problem, and thus the objective of this research, is to determine which tools, and their associated methodologies, fit within the Information Systems Command's (ISC) purview.



BASIS: An element of the ISC, the Information Systems Engineering Command (ISEC), along with countless other large organizations charged with the development, operation and maintenance of automated systems, is facing several emergent computer software crises: new or modified applications are being demanded faster than they can be developed and, as the systems themselves become more complex, there is a growing backlog of unfulfilled requests for changes to software systems with higher attendant costs. Software engineering techniques such as Reusable Software Components (RSCs) appear to be a possible solution to overcome these problems. But a RSC is dependent on software engineering tools; and even

though Computer Aided Software Engineering (CASE) tools are being advertised for more and more uses, the range of benefits anticipated is not being met. The tools are not always appropriate for the task, nor are they often integratable into the proposed environment. ISEC has not had the success they should have in the Ada software development arena due in large part to the lack of tool support. Also, the methods used in the COBOL environment are not applicable in the Ada environment. This research should help them balance tools, methods and life cycle phases.

**APPROACH:** The project has been divided into four steps. First, and most important to the ISEC environment, the establishment and implementation of a prototype Intelligent Testbed (ITB) for software tools will be undertaken. The ITB will be an automated means to assess tools characteristics and specifications, methods, and life cycle phases. The interplay among elements will be used to match the attributes common to all. The primary use would be based on ISEC's knowledge of methods and life cycle phases, to gain features of either available or potential tools. However, other approaches are available and are applicable. Second, a survey will be performed on state-of-the-art RSC and CASE tools that could be used in a STAMIS application. Third, an investigation will be implemented into the appropriateness of comparing one development methodology for requirements and specification analysis against other methodologies. The baseline method would be one of the newer methods — the Vienna Development Method. And four, the development of prototype tools for demonstration on maintenance workstations will be performed. This element of the project is more in line of a proof of principle demonstration, a culmination of the other tasks. Of concern is the issue of portability. The research environment will be fixed, i.e. UNIX, but the tools selected will be able to span different platforms.

**ACCOMPLISHMENTS:** The contract was awarded on 16 February 1989 to Georgia State University (GSU) and was scheduled to be in effect until 31 December 1989.

The project initiation meeting was held 15 March 1989 in AIRMICS' conference room. Details of the research were finalized based on the Statement of Work.

The first IPR was held on 9 June 1989 at AIRMICS. Task layouts, schedules, assignments and progress made to date were presented by the GSU staff working on the project. The primary purpose of the meeting was to insure all

involved that work was being started on the primary issues and in the correct direction. Presentations were well received and the work was progressing satisfactorily. Specifically, the tools survey found that approximately 2000 tools have been advertised. Of these tools, less than 10% of mainframe users have purchased them. Of those in use, 80% are on an experimental basis. Most are aimed at new applications development, not for migrations, enhancements, or maintenance. A function point productivity estimation tool was a possible candidate for prototyping in task 4.

On 26 October 1989, the principle investigator and his team briefed AIRMICS concerning the current status of the multi-tasked project. A video was shown, created by the team, outlining the purpose, objective, and results of the ITB, task 2. The ITB system is being ported to the newly acquired MAC IIcx. Dr. Kumar provided an insight into the product to be produced in task 1 by comparing the Problem Statement Analyzer/Problem Statement Language (PSA/PSL) and the Vienna Development Method (VDM).

On 4 December 1989, Dr. Gagliano and others provided a live demonstration of the ITB. The system is completely mouse driven. Selecting icons or key words, numerous levels of pull-down and pop-up menus of text information are displayed. The information at the various levels shows the working relationships among methods, tools, and life cycle phases.

A no-cost extension was granted to February 1990, so the ITB could be populated to a greater extent and the final report finished. The final report was received at that time and will be distributed. To date, several groups, including the Information Software Support Center (ISSC), have shown an interest in expanding the prototype ITB. This project is a natural lead-in to the Small Business Innovative Research (SBIR) project CISD is accomplishing in the area of an Ada Programming Support Environment (APSE) Definition. ISSC has taken an active role in the SBIR project, and therefore, is seeking more information on the ITB and its associated work.

**PLANS FOR NEXT QUARTER:** The project has been completed.

**PUBLISHED REPORT:**

Gagliano, R.A., Fraser, M.D., Owen, G.S., Conger, S.A., Kumar, K., McLean, E.R., "Assessment and Development of Software Engineering Tools," Final Research Report, March 1990.

The final technical report on this project consists of three main sections and four appendices. The appendices contain copies of two papers and two user guides. These are direct results of the research. In the main body of the report are contained discussions of the relevant issues in the research. Those are: 1) the analysis of the need for, and the development of, software tools for demonstration on a prototype software maintenance workstation; 2) a review of potential Reusable Software Component (RSC) and Computer-Aided Software Engineering (CASE) tools; 3) a preliminary investigation into the appropriateness of the Vienna Development Method for software requirements and specification analysis; and 4) an implementation of a prototype Intelligent Testbed which is an example of a software tool that has application for both software tool needs assessment and analysis.

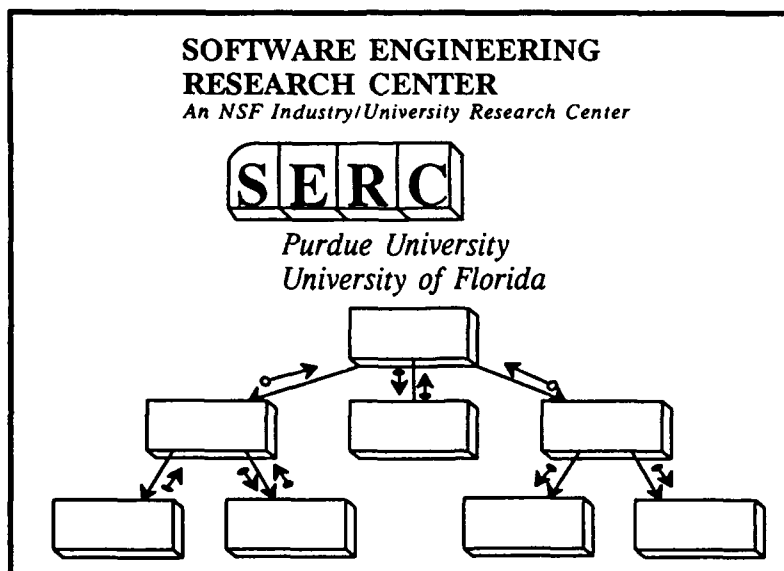
**g. TITLE: Software Engineering Research Center (SERC)**

POC: Mr. Glenn Racine and Mr. Daniel E. Hocking; (404) 894-3110

CONTRACTOR: University of Florida and Purdue University

OBJECTIVE: The center is to help meet the needs of its affiliate members in the area of software engineering. It will focus on the development and assessment of tools and methodologies that have the potential to increase programmer productivity and improve software quality and reliability.

BASIS: Several years ago the National Science Foundation (NSF) was chartered to establish centers of industry-university cooperative excellence. One of these established centers of excellence is the Software Engineering Research Center at Purdue University and the University of Florida. By joining in this cooperative research center, AIRMICS can effectively leverage the limited AIRMICS funds which are applied to this project. With the current membership, AIRMICS is sharing in \$480,000 of research this year for the annual membership fee of \$30,000.



APPROACH: The center, established under the NSF Industry-University Cooperative Research Center Program, is sponsored by the federal government, private industry, academic institutions and the Florida state government. A five-year grant totaling \$500,000 has been awarded by the NSF to help establish the center. The Florida High Technology and Industry Council has made a five-year commitment of \$300,000 to the center. This

will be supplemented by membership fees of \$30,000 per year from U.S. industrial and governmental organizations. Co-directors of the center are Dr. Richard DeMillo of Purdue University and Dr. Stephen Yau of the University of Florida. AIRMICS serves as the technology transfer vehicle to either use the center results in other research we are conducting or supply these results directly to command elements. All center research products are available for use throughout ISC.

The SERC's research results become the products and services of its members. AIRMICS will use selected results (which are in the form of research papers, software programs, and reports) in other projects, either within AIRMICS or in contractual efforts.

#### ACCOMPLISHMENTS:

The Fall Industrial Advisory Board Meeting was held 14-16 November at the University of Florida. Project reviews, presentations of new proposed projects, SERC accomplishments, and plans were the main topics of the meeting.

Now that SERC is entering its fourth year, a number of software prototypes are available for demonstration and, in many cases, for distribution to affiliate organizations. Projects that have produced software include:

- Large Scale Software Cost and Size Estimation
- Scenario-Based Requirements Engineering
- Intelligent Programming Environment
- Specification and Processing of Applications in a Distributed Heterogeneous Environment
- Design Format Transformations
- Automatic Generation of User Interfaces
- Use of Fifth Generation Computers for High Performance Reliable Software Testing
- New Approaches to Software Debugging
- Dependency Analysis Methodologies for Software Maintenance
- Program Change Analysis Methodologies for Software Maintenance

If you would like to schedule a demonstration, or if you would like to investigate the possibilities of obtaining the prototype software for your own use, please contact AIRMICS.

#### PLANS FOR NEXT QUARTER:

The work in the listed projects continues.

PUBLISHED REPORTS:

There have been more than fifty published reports from the SERC in the last year of which thirty have relevance to the IMA. Abstracts are available from AIRMICS for each of these reports as are the reports themselves. For either electronic copies of these abstracts or paper copies of the reports, please contact Mr. Glenn Racine.

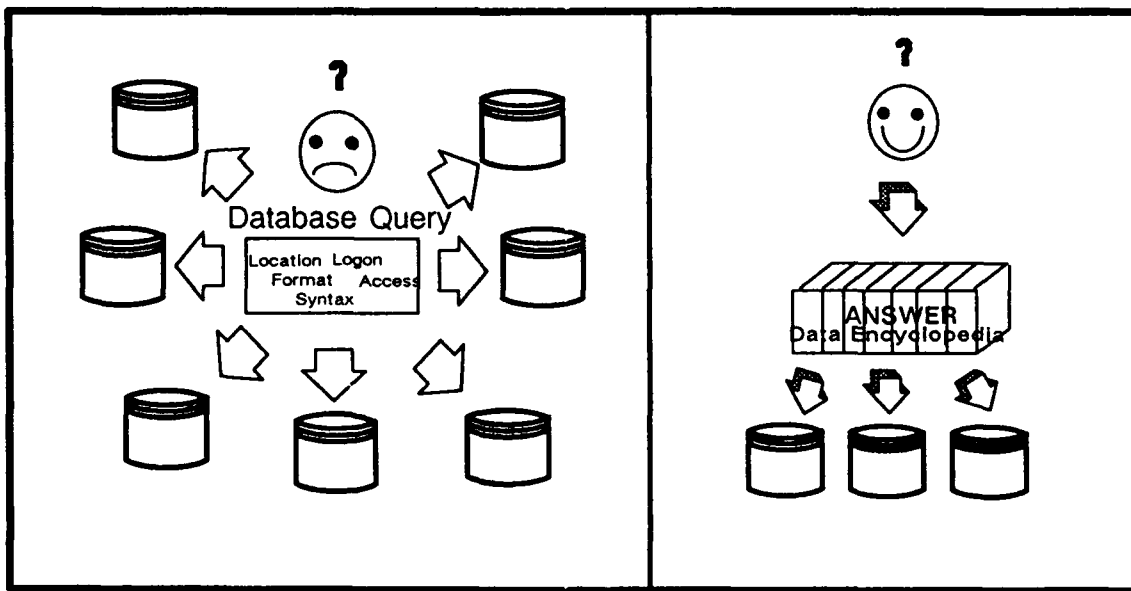
## 2. VERY LARGE DATABASE RESEARCH

### a. TITLE: Development of a Database Encyclopedia (ANSWER) for Distributed Systems

POC: Major David S. Stevens; (404) 894-3110

CONTRACTOR: Honeywell Federal Systems Inc.; Dr. K. Ryan

**OBJECTIVE:** This project will perform research in the concept and design of a system to allow nonprogrammers, information system planners/developers, and database administrators access to Army Information Systems via an encyclopedia facility. This facility is a unified reference catalog for the processes, information classes, and associated databases of the Army Information Model (AIM) and tools to aid Army personnel in locating and retrieving relevant data. The prototype supports the ISEC target information architecture to include sharing of data among systems, separation of data and applications, and providing more processing power closer to the user.



**BASIS:** It is technologically impossible to implement a truly distributed information system as desired by the Army because the requirements for accommodation of heterogeneity, security, and operational capability such as survivability and availability exceed state-of-the-art technical capabilities. Advances in technology are needed in order to implement these systems. The optimal architecture must satisfy the requirements in hardware, software,

communications, and security. The encyclopedia approach offers a potential resolution of this problem.

**APPROACH:** Initially, surveys and discussions were held to determine the current architectural state of very large systems from both a desired current and future operational viewpoint. Deficiencies and successes were documented and disseminated. Research tasks were implemented to address information resource classification, integration, and retrieval; communication requirements (access and response to queries that traverse multinodal data locations) via simulations and studies; security (responding to multi-level security (MLS), on-line linked databases) issues via technical reports and demonstrations; and hardware requirements (feasibility of database machines, hypercube/connectionist approach, artificial/neural net machines/parallel architectures) via simulations.

**ACCOMPLISHMENTS:** This project was awarded to Honeywell Federal Systems, Inc. on 30 May 1988 as a one-year effort with two option years. The first year effort included a demonstration of the preliminary elements of the ANSWER system to the command in third quarter FY89.

The initial IPR was conducted 14 June 1988 at AIRMICS. The Honeywell research team briefed the overall program and discussed the requirements analysis process, including a planned meeting and interviews with proponents from within the command and DISC4 in mid-July.

Subsequent IPR's were attended by personnel from DISC4, ISSC-SPOD, ISSC-DMD, STAMOD, and Lawrence Berkeley Labs to discuss the project, its relationship to other on-going efforts, and leverage the results of previous activities.

A preliminary prototype was demonstrated at CSDD in Minneapolis, MN in February 1989. The browser and schema integration capabilities were demonstrated.

An IPR was conducted on 9 June 1989 at Fort Belvoir, VA for representatives of AIRMICS, DISC4, ISSC-DMD, and ISSC, demonstrating the integrated tools developed during the 2nd quarter of FY89. A SUN workstation was delivered to ISSC-DMD with the current version of the software to permit ISSC-DMD to train on the system, to test the products, and to provide demonstrations to the command.

An ANSWER training/planning session was conducted on 21-23 June at Fort Belvoir for representatives from ISSC-DMD and AIRMICS. Personnel from

ISSC-DMD were trained on various tools to include schema integrator, database registration, and browser.

A demonstration of the ANSWER prototype was given on 7 September 1989 at ISSC-DMD. Personnel from PM ISM, ISSC-SPOD, AMC-SIMA, and PM RCAS attended. AMC requested a copy of the prototype to assist their efforts in accessing distributed heterogeneous databases.

On 1 November 1989, Dr. Karen Ryan of Honeywell Federal Systems presented the ANSWER project at FEDCASE 89 held at the National Institute of Standards and Technology. The presentation was well received.

PM ISM hosted a meeting on 2 November 1989 with representatives from AIRMICS, DISC4, ISSC-DMD, and Honeywell Federal Systems attending. The participants discussed the possible fielding of the ANSWER prototype at an ISM testbed installation. ANSWER will be used in this proof of principle demonstration as an interface mechanism for SAACONS/SARSS/ SAILS. This effort depends upon availability of funds.

On 16 February 1990, ISEC-DMD hosted a meeting in Boston with representatives from AIRMICS, ISSC-DMD, Department of Transportation Technical Services Center, and Honeywell Federal Systems. The participants in this meeting discussed the "productization" of the Data Element Creation Tool enhanced under the ANSWER project.

On 4 May 1990, Honeywell Federal Systems presented an overview of the ANSWER program to USAISEC representatives.

Representatives of DISC4, ISEC-SID, ISSC-DMD, MITRE, and PRC attended an IPR on the conclusion of Phase II at AIRMICS on 13 December 1989. The Phase II prototype was demonstrated and was well received. The prototype consisted of a data management tool set integrated under X-windows to include database registration, schema integration, browsing, an AI-based standard data element naming tool, and an IRDS repository.

On 13 June 1990, PM ISM hosted a meeting attended by representatives from AIRMICS, PM ISM, PM SAACONS, APRO, OCSA, and Honeywell Federal Systems. The purpose of this meeting was to discuss the applicability of the ANSWER tool set to the overall ISM effort.

An IPR on the conclusion of Phase III-A was held at Fort Lee, VA on 21 September 1990 in conjunction with COL Byrd's workshop on the Installation

Integrated Database. The Phase III prototype was demonstrated and was well received. The current version of the system added a query formulator and a query processing module. The query formulator takes a user not familiar with the databases registered with ANSWER and assists them in creating a correct SQL statement. The query processor takes the SQL statement and executes it using several heterogeneous databases. Representatives of numerous commands attended the IPR.

PLANS FOR NEXT QUARTER: PM ISM funded Phase III-B of this project. Prototype demonstrations will be given at AIRMICS to anyone requesting a demonstration. To schedule a presentation, contact the AIRMICS representative, Major Stevens, at (404) 894-3110. Meetings are being scheduled to incorporate ANSWER into the Installation Integrated Database for the ISM proof of principle demonstration. The Joint Transportation Command at Scott Air Force Base is interested in using ANSWER to integrate their heterogeneous databases to support Operation Desert Shield. Other government organizations have also expressed interest in taking ANSWER from a prototype system to a full production product. All these options will be explored during the next quarter.

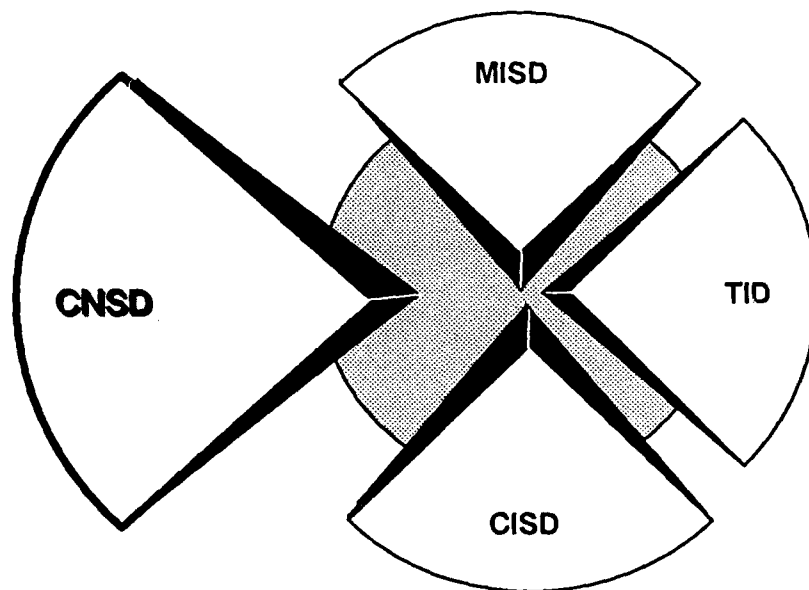
#### PUBLISHED REPORTS:

1. Honeywell, "ANSWER Interim Technical Report," DAKF11-88-C-0024 December 1988.
2. Honeywell, "ANSWER Browser Documentation," June 1989.
3. Honeywell, "ANSWER Tools Manual, December," DAFK11-99-C-0024, December 1989.
4. AIRMICS, "ANSWER Phase I Final Report," ASQBG-I-89-027, July 1989.
5. AIRMICS, "ANSWER Phase II Final Report," ASQBG-I-90-005, December 1989.
6. AIRMICS, "ANSWER Phase III-A Final Report," October 1990.

### C. COMMUNICATIONS AND NETWORK SYSTEMS DIVISION (CNSD)

CNSD does research in Distributed Systems, and Communications and Network Technology.

CNSD conducts research in communications and distributed systems in support of the Information Mission Area (IMA) and transfers the results of this research to the Army. CNSD accomplishes this goal through research projects and technology transfer activities. We conduct research projects either through contract research using university or commercial enterprises or through in-house efforts by AIRMICS engineers and scientists. Technology transfer activities include publishing reports of research, reviews of technology, participation in DOD working groups, maintenance of customer relationships and supporting other AIRMICS' missions.



The research projects conducted by CNSD develop tools, techniques, and prototypes for the design, implementation, transition and maintenance activities of various technologies of importance to the Army. In communications, CNSD conducts research in ISDN, FDDI, and LAN/WAN. In distributed systems, CNSD actively pursues projects in distributed architectures that support ISA 97 and the Army architecture in an open systems environment. Projects include distributed databases, communications, and interoperability among heterogeneous databases. Work progresses to

integrate COBOL technology with RDBMS technology during a transition period to relational technology.

In July 1990, CNSD participated in the North American Integrated Services Digital Network User's Forum (NIU-Forum) in Gaithersburg, MD. The forum continues to identify a broad range of ISDN users concerns, to create a strong user voice in ISDN applications, and to reach consensus on ISDN implementation agreements. CNSD also participated in the ACTS ISDN Working Group meeting and discussed the AIRMICS-CNSD experiment projected to be on board when the satellite is launched in 1992.

In September, CNSD attended the ACTS experiment Working Group meeting at NASA Lewis Research Center in Cleveland, OH. LTC Hanratty presented the AIRMICS ACTS ISDN experiment to the attendees. The presentation was well received.

The IEEE published LTC Hanratty's paper entitled "Performance Analysis of Hybrid ARQ Protocols in a Slotted Code Division Multiple-Access Network: Jamming Analysis" in their July 1990 special issue Journal in Selected Areas in Communication. This is a refereed paper in a top line journal.

CNSD participated in a DCA working Group meeting on DSN in Reston, VA in July 1990. The visit included several briefings by the attendees. The attendees represented ISC, ISEC, ISMA, DOD, DCA, DCEC, JITC, JTC3A, AT&T, Computer Science Corporation (CSC), and NSA.

On 15 August 1990, CNSD initiated a new contract to design and to implement the Master Schedule of Activities (MASSCHACT). This system supports the MDW Ceremonies and Events Directorate located at Fort McNair. PM-ISM funds this project and bases the requirements for this project on a similar program from West Point. The MASSCHACT will be written so that it can be implemented at other installations.

AIRMICS conducted a final review of the project entitled, "Specification and Analysis of Parallel Machine Architecture" in February 1990. Professor C. V. Ramamoorthy and Mr. M. Kim of the University of California, Berkeley, presented the final report for the first year of the effort toward developing a single integrated tool with which we can specify, simulate, and analyze a particular application (software) running on any given parallel (distributed) architecture (hardware). A demonstration of some of the tools recently

developed followed the presentation. This project was not renewed into the second option year because of funding constraints.

CNSD visited Redstone Arsenal several times during the reporting period to coordinate ISDN activities. These visits enable AIRMICS to keep pace with the progress of the Army's only full scale ISDN implementation. Numerous discussions were held relative to the assistance AIRMICS can provide to Redstone in this important work.

We completed the following projects: Message handling in the Post 2000 Era, and EPIC.

Funding constraints caused AIRMICS to cancel Research in Distributed Systems and Parallel Machine Architectures and The Multimedia Network Design Study.

If you are interested in any of the above areas discussed in this Research Status Report, or have questions relating to CNSD, please contact Dr. Jay Gowens, e-mail address [gowens%airmics@gatech.edu](mailto:gowens%airmics@gatech.edu), phone (404) 894-3106 or 894-3110.

## 1. DISTRIBUTED SYSTEMS RESEARCH

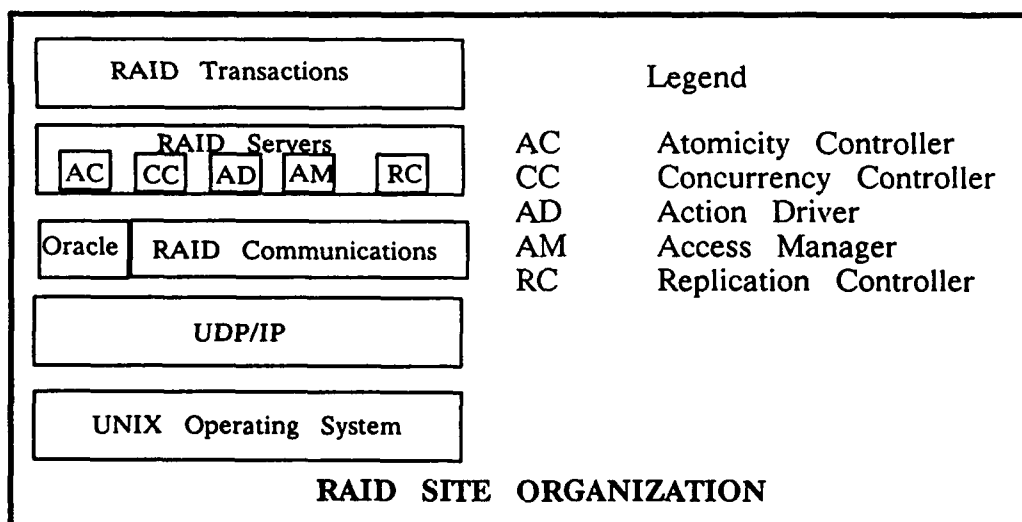
### a. TITLE: Design and Implementation of an Adaptable Distributed System

POC: Mr. Son Nguyen; (404) 894-3136

CONTRACTOR: Purdue University; Dr. Bharat Bhargava

OBJECTIVE: To formalize and experiment with design principles that allow for the implementation of an adaptable distributed system.

BASIS: Adaptable systems are those that can be changed at run time based on performance, continuity of operations requirements, and load conditions. This flexibility makes it suitable for diverse applications and allows for the incorporation of new distributed systems technology as it becomes available, which is unlike existing systems. In addition, this research will provide insight on how to improve database reliability, access multiple heterogeneous databases located at different locations, heterogeneous databases, and define the requirements needed to maintain current information throughout the system.



Adaptable distributed systems are relatively new, at least in the environment in which the Army must operate. The name alone implies a degree of change and dynamism not found in our batch-oriented transaction systems. This research will investigate new design strategies and techniques that can be used to make our future systems more robust and adaptable to the dynamic environment in which they operate.

APPROACH: Initially, software for the distributed system will be designed and implemented on a prototype adaptable distributed system called the Robust,

Adaptability, and Intelligence in Distributed Database System (RAID). This software corresponds to various levels of the distributed system to include transaction (TR), remote procedure call (RPC), and upper level I/O (UIO). Next, the formulation of conditions necessary to switch algorithms without affecting the correctness of the history of concurrently executing transactions will be developed. After verifying the correctness of the software developed above, prototype systems to support heterogeneous data objects will be developed. Finally, the design principles and issues on the capability of dealing with heterogeneous databases, diverse applications, high reliability, and performance will be identified.

**ACCOMPLISHMENTS:** This is a joint research effort between AIRMICS and NASA. The contract for the research was renewed 15 April 1989 for a period of one year.

An upgraded version of the mini-RAID prototype was installed on a SUN Workstation at AIRMICS for in-house test and evaluation on 27 June 1988.

An IPR was conducted on 27 June 1988 at AIRMICS. During the review, the results of current communications experiments, a comparison of RAID to the Information Architecture Reference Model (IARM), and four technical papers were discussed.

An IPR was held at Purdue University on 15 November 1988 to discuss recent research results. The topics discussed were: Quorum-Based Database System for Experimentation with Failure, High Level Tool for Analysis of Distributed Systems, Programs for Communication Protocols Definition at the Kernel Level, and Object-Relation Model. Implementations relating to these topics were demonstrated as well.

An IPR was held at AIRMICS on 25 April 1989. Participants included representatives from ISC/ISEC, CECOM, SIGCEN, DCA, Strategic Defense Command, Purdue University, and AIRMICS. The following topics were discussed: Relationship between IARM and the RAID system (the IARM model was developed by AIRMICS as an in-house project), Object-Relation Model in Object-RAID, and Experiments on Communications and Mini-RAID.

The installation of the RAID software system on the AIRMICS testbed using the SUN network was completed. This system will be used for experiments in concurrency control, replication management, and other services for transaction processing.

An IPR was held at Purdue University, 31 October - 01 November 1989. The review was attended by representatives from AIRMICS, NASA, Honeywell, and the Purdue Computer Sciences Department. The project is developing the principles necessary to build high performance, reliable, and reconfigurable distributed database systems to provide users access to a multi-database network from distant locations. Implementation of the system to deal with concurrent transactions, data replication, communications, network dynamic reconfiguration, and complex data objects in complex databases were discussed. The current software version of the RAID system was released to AIRMICS for evaluation.

An IPR was held at AIRMICS, 26 April 1990. The review was attended by representatives from ISEC-SAO, ISEC-SID, Rome Air Development Center, AIRMICS, and the Purdue Computer Sciences Department. The following topics were discussed: Database replication and reliability in dynamic reconfiguration network, communications in heterogeneous environment, and complex database objects. The complex database objects will provide capabilities for a large variety of information storage and access to the information through high level user interfaces with built-in intelligence. ISEC-SED, ISEC-SAO, ISEC-SID, Army Research Office, National Institute of Standards and Technology are identified as the potential users.

**PLAN FOR NEXT QUARTER:** It is planned to award a follow on contract to Purdue University to continue the research. The research on the RAID system is expected to be completed during the next two years. AIRMICS will participate in an IPR to be held at the University in November 1990.

#### **PUBLISHED REPORT:**

Bhargava, B., E. Mafla, and J. Riedl, "Communication in the RAID Distributed Database System," Purdue University, 1990.

This paper identifies the basic functions required from a communication subsystem in order to support a distributed, reliable, reconfigurable, and replicated database processing environment. These functions include: reliable multicast, different types of remote procedure calls, inexpensive datagram services, and efficient local interprocess communication. This paper also discusses a services of experiments that measure the performance of several local interprocess communication methods, a kernel-level multicasting facility, the RAID system running on different network configurations, and a so-called Push multicast program.

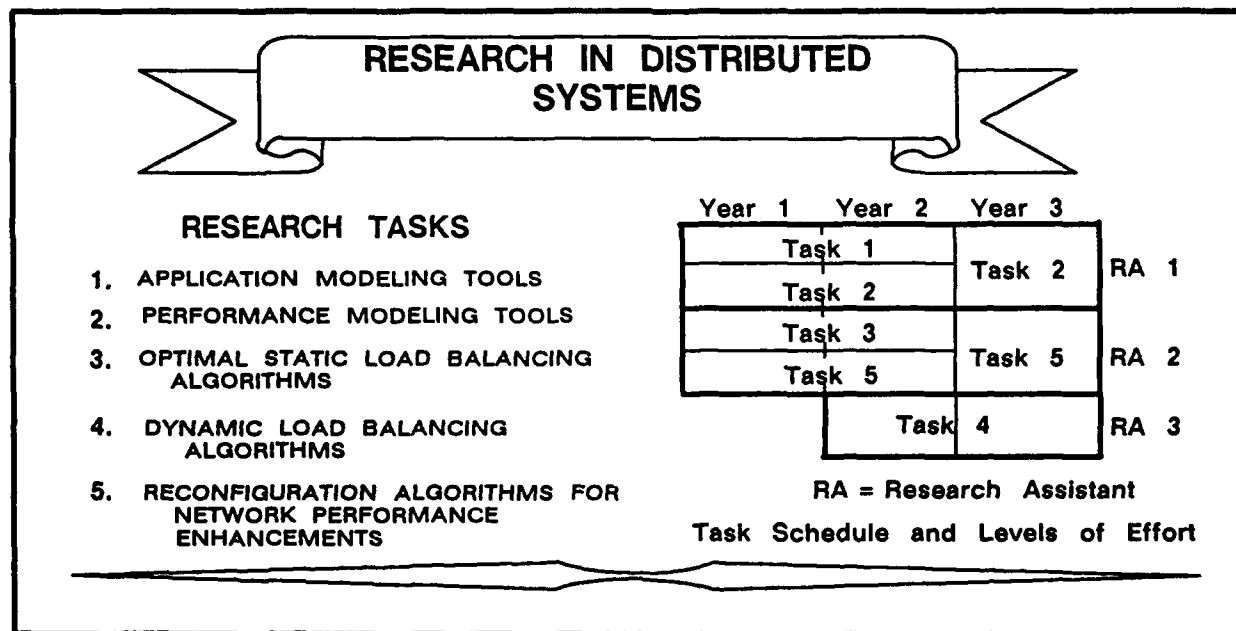
**b. TITLE: Distributed System Architecture Modeling Tools**

**POC:** CPT Tim O'Hara; (404)894-3136

**CONTRACTOR:** University of Southern California; Dr. James Yee and Dr. John Silvester

**OBJECTIVE:** The development of tools to model a general class of distributed systems with particular emphasis on performance prediction and enhancement.

**BASIS:** Implementation of distributed systems will effect changes in the areas of "automation of information" and "the exchange of information between sustaining bases" within ISC and the Army. A distributed system has the potential to improve efficiency, reduce costs, and by using several processors, solve problems that were prohibitive in the past. Thus, increasing the support (at a reduced cost) ISC provides its customers.



**APPROACH:** This project is a one-year effort with two follow-on option years. The project is divided into five separate tasks. Some tasks are performed concurrently.

**Task 1:** Application modeling tools. A graphical representation of the processes comprising an application will be modeled.

**Task 2:** Performance modeling tools. Determines the performance (throughput/delay) of the jobs mapped to hardware in a specific

configuration. Ideally, these performance models will be generated automatically from the application model and system configuration.

Task 3: Load balancing algorithms. Determines how the jobs and message traffic should be assigned to the processors so that the overall response time is minimized.

Task 4: Adaptive performance enhancement algorithms. The solutions found in Task 3 will result in a static allocation of subtasks to processors. In some cases additional advantages are gained from dynamically allocating tasks to specific processors or moving jobs to alternate processors. This task will develop an appropriate algorithm to accomplish dynamic allocation.

Task 5: System reconfiguration (optimization) tools. Using the algorithms developed in Task 3 and Task 4, additional tools to modify the system configuration, and to optimize the system performance (throughput, delay, reliability, etc.), subject to a bound on the cost of the improvements, will be developed. These tools can be used for system sizing and capacity planning.

**ACCOMPLISHMENTS:** AIRMICS awarded the contract to the University of Southern California on 16 March 1989.

The initial meeting was held at AIRMICS on 20 April 1989. Attendants were representatives from ISEC-SED, ISEC-TED, SIGCEN, Strategic Defense Command, DCA, CECOM, and DISC4. Constructive concerns were raised by participants such as the applications of the developed tools on Army systems, Human/Social/Organization vs. Models Implementation, network size for load balancing, etc. The discussions on these subjects helped formulate the tasks in this project. In December 1989, USC delivered two papers entitled "Locating Internet Gateways to Minimize Nonlinear Congestion Costs" and "Optimal Distributed Routing Algorithms for Datagram Communication Networks".

The first year work was completed with the submission of the First Year Final Report. The follow-on option years were not exercised because of funding limitations in FY90.

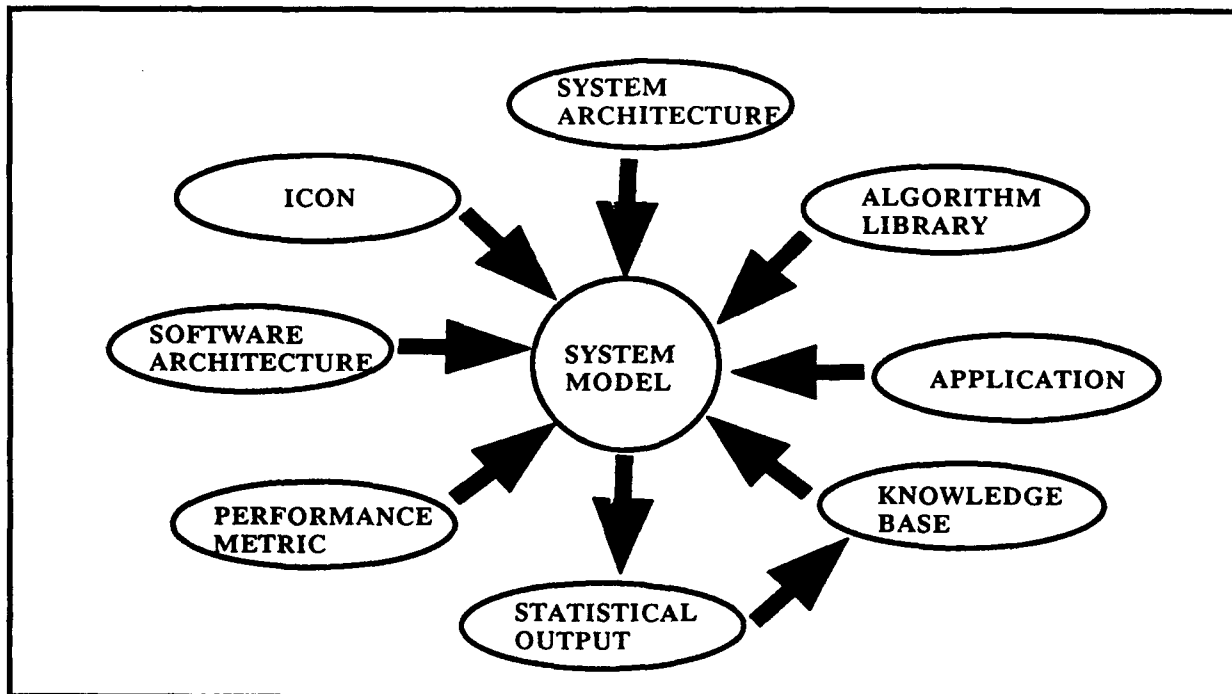
**c. TITLE: Environment for Simulation Modeling of Distributed Systems**

POC: Mr. Son Nguyen; (404) 894-3136

CONTRACTOR: Innovative Research Inc.

RELATED CRITICAL ISSUES: Decentralized Systems

OBJECTIVE: The objective of this task is to specify and develop a support environment for hosting distributed system models. The initial focus of the research will be to define the support environment and to provide a proof-of-concept prototype. Actual development of the support environment will follow using the requirements defined in the prototype.



BASIS: As information systems become more and more decentralized, current system applications must be modified to match the distributed nature of the network. Currently, many elements of DOD (e.g., DARPA) are developing distributed system applications using distributed design environments such as Cronus. The current research is expected to aid the Army by developing methods for evaluating how effectively distributed systems will be used within the Army. The tools developed under this

research will enable system engineers to effectively simulate a given distributed system and evaluate its associated applications. This requires a support environment that is well suited to distributed systems which are characterized as having a large number of complex interdependent processes. The research will also address general methods for designing simulations for use in parallel processing systems.

**APPROACH:** The prototype environment will consist of a modeling tool and a set of support tools. The first phase of the task will be to define the above environment while the second phase will be to implement the environment. The modeling tool will consist of five elements which will be defined in detail by the contractor. The five elements are: an architecture specification element, software architecture definition element, application description element, sub-system library element, and model control element. The support tool will consist of an algorithm library involving statistic routines, queuing network algorithms, optimization routines, etc.; a knowledge base to aid the user with the algorithm library; and a knowledge base to aid with output analysis.

**ACCOMPLISHMENTS:** The contract was awarded on 5 July 1989. A coordination meeting was held to discuss the most appropriate application to demonstrate the prototype environment. The particular application for demonstration is still under consideration. It will have some provisions for incorporating a distributed operating system, and the large number of processes which may be present in a set of distributed transactions.

Five elements of the modeling tool, as mentioned above, were defined and described in detail. The Cronus distributed operating system description was delivered to the contractor. This system will be used as a model for the communications among processors.

An IPR was held at Fort Huachuca on 10 January 1990 to brief and demonstrate the prototype product which was completed during Phase I. A survey was conducted to measure the audience's expectations and recommendations. Representatives from ISEC-SED, ISEC-SAO, and ISEC-TED showed strong interest in the product, and recommended that the

project be continued. They also commented that the product has potential use in solving many problems in their organizations.

A proposal for Phase II to complete the development has been submitted to the SBIR Program Office for funding consideration. SED and SAO have completed a review of the proposal. The two directorates' comments and recommendations will be discussed during the kickoff meeting which is expected to be held at AIRMICS during the first quarter of FY91.

**PLANS FOR NEXT QUARTER:** A contract is planned to be awarded to Innovative Research Incorporated to continue the development when funding from the SBIR program is available in FY91. An initial program meeting will be held in the first month of the contract period.

**PUBLISHED REPORT:**

Pazirandeh, M., "An Environment for Simulation of Distributed Systems," ASQB-GC-90-014, February 1990.

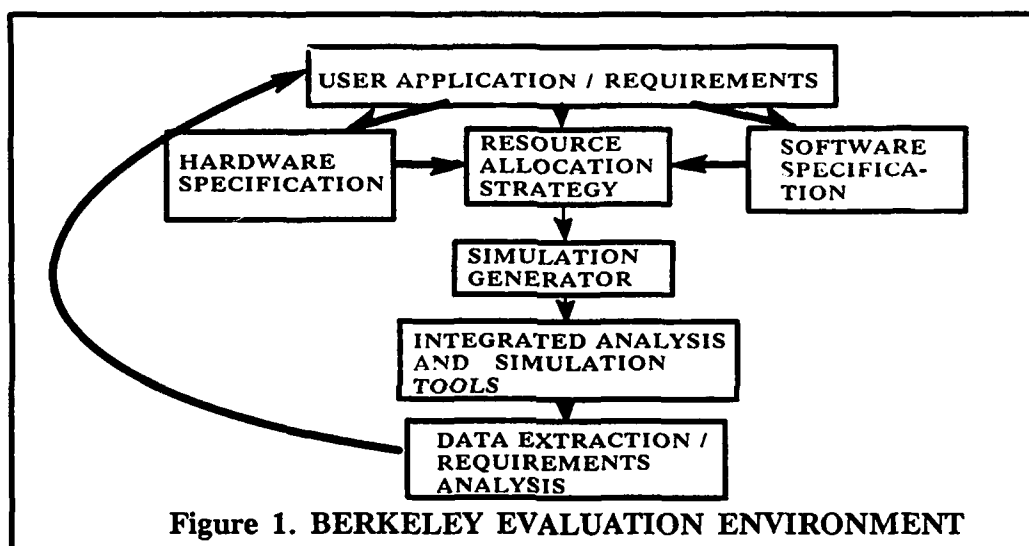
The report discussed the feasibility of developing an environment for the simulation of distributed systems, and building a prototype version of the proposed environment to show some of its capabilities. The research shows that such an environment can be developed and must contain a number of libraries including hardware components, operating systems, DBMSs, algorithms, performance measures, and several knowledge bases. The capabilities of such an environment was demonstrated via the implementation and assessment of the performance of a distributed database implemented under a DBMS, native operating system, and the Cronus distributed operating system.

**d. TITLE: Analysis of Computer Architectures**

**POC:** LTC Joseph M. Hanratty; (404) 894-3136

**CONTRACTOR:** University of California, Berkeley; Dr. C. V. Ramamoorthy

**OBJECTIVE:** The objective of this research is to develop an evaluation environment in which a particular software application running on a given parallel (distributed) machine architecture can be defined, simulated, and evaluated. Here, a single high level specification language is used to specify and analyze both the software application and the hardware architecture.



**APPROACH:** The research is divided into three phases, each of which is one year in duration. During the first phase, the principle investigator (PI) will evaluate the relative advantages and disadvantages of the existing hardware description languages and simulation tools. The Berkeley Requirements Statement Language (BRSL) will then be extended to support hardware description while incorporating those important aspects of the surveyed languages. During the second phase of the research, the extended BRSL will be evaluated in terms of its feasibility, descriptive power, and suitability to represent various architectures. Performance metrics will be identified, and benchmark programs will be developed. A prototype evaluation environment will then be developed and tested against a number of applications/architectures combinations. Finally, the performance variation of a given application/architecture due to resource variation will be studied. The

last phase of the research will extend the phase two prototype to include a static analyzer and a high-level benchmark system (simulator). The final result will be a fully integrated software/hardware evaluation environment as shown in Fig. 1.

**ACCOMPLISHMENTS:** The contract was awarded on 8 March 1989.

An initial meeting was held on 19 April 1989. Discussions included the project as a whole and specific approaches that will be taken in order to extend the Berkeley Requirements Statement Language (BRS�) to incorporate hardware architectures.

The first quarter performance (March-May) report included a survey of existing hardware description languages. The survey reviewed seven hardware description languages and analysis tools suitable for analyzing, simulating, and specifying parallel machine architectures. Application independent and application dependent metrics were also defined.

Research during the second quarter (June-August) included a further study of software and hardware description languages which can be used to specify parallel/distributed machines. BRS� was further developed to include a graphical editor for entering BRS� programs into the system, an interpreter for translating BRS� software/hardware descriptions into internal data structures, and analysis tools for analyzing BRS� specifications.

Research during this quarter (September-November) involved surveying and developing various tools and techniques for distributed simulation and monitoring/controlling distributed computation. The performance report for this quarter included a survey of possible candidates for distributed simulation, and a description of a particular tool for monitoring/controlling distributed computation: the Network Event Manager.

An In Process Review (IPR) was conducted in February 1990 which completed the first year of the research. AIRMICS was provided with a prototype evaluation environment. This prototype was made available to ISSC Technical Support Directorate for evaluation to ensure that the prototype is suitable to the Army's needs.

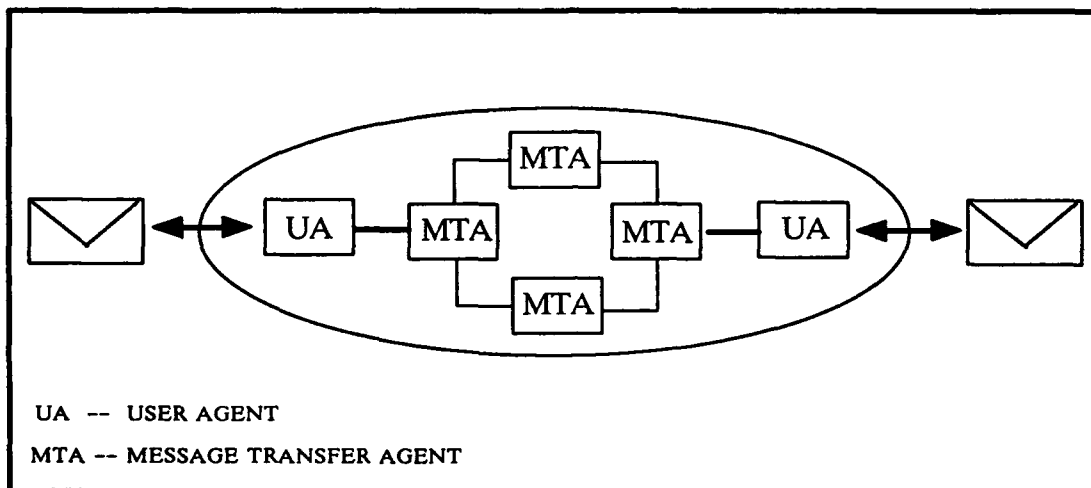
The option on this project was not exercised because of funding limitations in FY90. Any further work will be re-initiated as a new project.

**e. TITLE: Message Handling in the Post 2000 Era**

POC: Mr. Winfred Fong; (404)894-3136

CONTRACTOR: Georgia Institute of Technology (GIT)

OBJECTIVE: This project is a pre-feasibility study of message-handling techniques which exist today and which futurists forecast as possible. The study will include automated message handling techniques with primary focus on the Tactical through Sustaining Base areas of operations to the extent of defining a coherent message handling architecture for the Land Combat Zone.



**BASIS:** ISC/ISEC, as a major command in providing support for telecommunications, has also the responsibility to integrate communications between the Tactical and the Sustaining Base. In order to support the mission of ISC and the NATO Tactical Communications Post-2000 Memorandum of Understanding (TCP 2000 MOU), there is a need to assess the message handling function of networks to achieve an understanding of the possibilities for terminal capabilities for the Post 2000 era. The NATO communications community is studying new architectures and networks for the future where the concepts and technologies for communications and information disciplines should proceed to foster interoperability by means of common standards at a minimum cost. The overall message handling functions built into a network, therefore, must be assessed in view of the potential changes in network architecture, terminals, and technology.

**APPROACH:** The initial approach is to study message handling options and related architectures ranging from a highly centralized system to a highly

distributed system. The suitability of these options for both mobile and non-mobile subscribers will then be determined. The results of this study will be used to recommend a message switching architecture for the Post 2000 communications system. Finally, existing and planned communications standards will be examined for applicability to the required communications environment.

**ACCOMPLISHMENTS:** Funded by NATO, the contract was awarded to the Georgia Institute of Technology (GIT) on 24 January 1989 for a period of 9 months.

An initial meeting was held between the Signal Center, AIRMICS, and the contractor on 7 February 1989 at GIT facilities for discussion of the planned work. Project related materials were also delivered to AIRMICS for further study.

On 10 March 1989, an information briefing was provided by the Signal Center to the contractors at AIRMICS to familiarize them with the current Army IMA and the Signal Corps Vision.

A framework of functional and environmental parameters has been constructed on which the recommended message handling architecture will be based; the technology issues for the design of the lower three layers of the message handling network were identified.

In May, a meeting was held with representatives of the MITRE Corporation in Bedford, Massachusetts to discuss the Air Force's communications requirements for the post-2000 tactical theatre.

An In-Process-Review (IPR) was conducted on 11 July 1989 at the Signal Center, Fort Gordon. The contractor presented architectural options for message handling systems and a description of the far-term requirements for non-mobile and mobile subscribers as seen by NATO, the U.S. Army, and the U.S. Air Force. As a result of comments and recommendations gathered throughout the presentation, two briefings were attended by AIRMICS and the contractor at Fort Gordon. The first of these discussed the expected threat to tactical communications. The second was a demonstration of a state-of-the-art system for placement and simulation analysis of tactical communication systems.

In August, a video briefing was received from the Naval Data Automation Command, Washington, D.C. The briefings presented Naval plans for communication systems on the base level for the early part of the next century.

Due to the relocation of the contractor's office, the contract was placed under a two-month, no-cost extension.

The second IPR was held on 25 October at the Signal Center, Fort Gordon. A formal presentation on communications architectures for both mobile and non-mobile subscribers was presented by the PIs. The final IPR took place on 17 November at the Signal Center for review of communications standards under different networking requirements. The draft executive summary and final report were submitted to the Directorate of Combat Developments for their final review. The approved final report was received in December 89. Delivery of this final report brought the project to normal termination.

#### PUBLISHED REPORT:

Browning, Douglas W. and Wicker, Stephen B., "Message Handling in the Post-2000 Era," Georgia Institute of Technology, December 1989.

This technical report presents the investigation of options and related architectures for tactical message handling systems. It also includes the suitability of these options with respect to both mobile and non-mobile systems, an approach to future tactical communications standards, and a recommendation of a message switching architecture for the Post 2000 tactical communications environment. The results of this project also highly support ISC in the area of Defense Message System (DMS) architectural planning.

## 2. COMMUNICATIONS AND NETWORK DESIGN RESEARCH

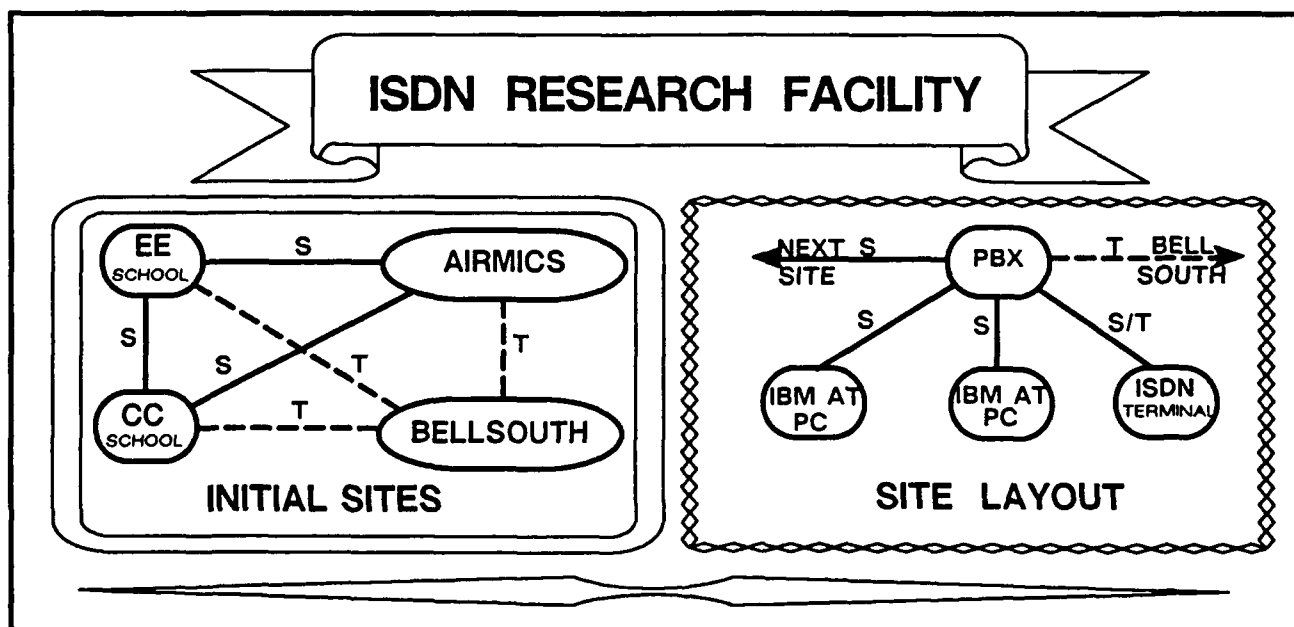
### a. TITLE: Technical Issues in Evolving to ISDN

POC: Mr. Winfred Fong; (404)894-3136

CONTRACTOR: Georgia Institute of Technology (GIT); Dr. Phillip Enslow

OBJECTIVE: This project will develop an applications research facility and evaluate the emerging Integrated Services Digital Network (ISDN) technologies. It involves research in the installation, analysis, and simulation of the future communications and networking components of the ISDN.

BASIS: Throughout ISC changes are occurring in the automation of information and the exchange of information between sustaining bases. ISDN is the objective configuration of the Army to support and manage this information flow. To effectively evolve to this objective configuration, the capabilities and limitations of ISDN must be understood so a comprehensive transition plan can be developed.



APPROACH: This phase was a one-year effort of a planned three-year project. This phase was divided into four major areas: hardware acquisition, quantitative measures, establishment of a test facility, and a comparison of new ISDN services to existing services. Initially the hardware and software

necessary for this project were identified. The remaining tasks were grouped into three areas. The first set of tasks developed the techniques and procedures to quantitatively measure and to evaluate the performance characteristics of the emerging ISDN services. The second task required the establishment of an ISDN applications research facility. The third set of tasks compared potential ISDN services to existing services in order to determine which services were the most useful to the Army.

**ACCOMPLISHMENTS:** AIRMICS awarded the contract to the Georgia Institute of Technology (GIT) on 3 February 1989. Under the contract, GIT will conduct research in the installation, analysis, and simulation of the future communications and networking components of the ISDN. This project will develop an applications research facility and evaluate the emerging ISDN technologies.

The initial coordination meeting for this project was held on 9 March 1989, at GIT in Atlanta, Georgia. The meeting included current research efforts at GIT in communications networking, electrical engineering, and a tour of GIT's Networking/ISDN Lab. The project generated genuine interest from the attendees representing OSD, DCA, ISC, ISEC, ISMA, SIGCEN, Bell Communications Research, Bell South Enterprises, AMD Inc., MCI, Novell, GIT, and other organizations.

ISDN interface boards have been acquired and installed in the research node at the EE school (GIT). The study on the electrical characteristics of the transmission line, the synchronization and the link-setup mechanism for point-to-point connection between different ISDN network interfaces was completed.

Two generic ISDN Terminal Adapters (TAs) have been designed and successfully prototyped using both Mitel and MOTOROLA semi-conductor chips. These TA devices provide interfacing capabilities between serial asynchronous ports and standard telephone sets to allow users to set up ISDN voice and data calls simultaneously over the S interface bus.

The move of the GIT College of Computing's ISDN node from the Networking Lab of the Rich Building to the new Communications & Networking Lab in the College of Computing Building was completed in September. The new facility enables the testbeds to have fiber optics connectivity between three research sites to allow further analysis of internetting LANs with ISDN.

Simulation of the D channel has been completed which allows non-realtime study of the characteristics of the D channel and analysis of its capabilities. A character timer which sends characters into a terminal adapter for transmission across the ISDN has been produced and is being modified to allow greater functionality. A packet level timer has also been prototyped. The outlines of an ISDN Handbook which is a guide to the engineering, procurement, installation, and operation of ISDN subscriber systems is completed.

Equipment for the AIRMICS ISDN Applications Research Testbed (ART) has arrived and has been installed. Equipment installation and acquisition will be an ongoing process in order to maintain the laboratory test facility at the level of the latest technology available in ISDN.

An IPR was held on 15 March 1990. The meeting was attended by approximately 50 attendees from both DOD and commercial organizations. The Principle Investigator presented an overview of the project, and went into detail on the final results and future plans for this joint project. A demonstration of both actual and simulated ISDN services and applications was also conducted at the end of the meeting.

In order for the contractor to finish the deliverables, the project is currently under a 7 month no-cost extension until 30 November 1990.

A multimode fiber optics cable is run between the College of Computing's ISDN node and AIRMICS ART. This cable is used to provide end-to-end connectivity for the Teleos switches which are used to simulate two independent central office environments. These environments allow researchers to evaluate and measure ISDN performance characteristics which otherwise cannot be performed in an actual ISDN environment.

**PLANS FOR NEXT QUARTER:** To continue on the analysis between ISDN services and other packet switched services to include data handling in packet formats within both the B and D channels. Continuing with the equipment setup for the ISDN node within AIRMICS as well as the testing of ISDN-related equipment.

**b. TITLE: Center for Telecommunications Research (CTR)**

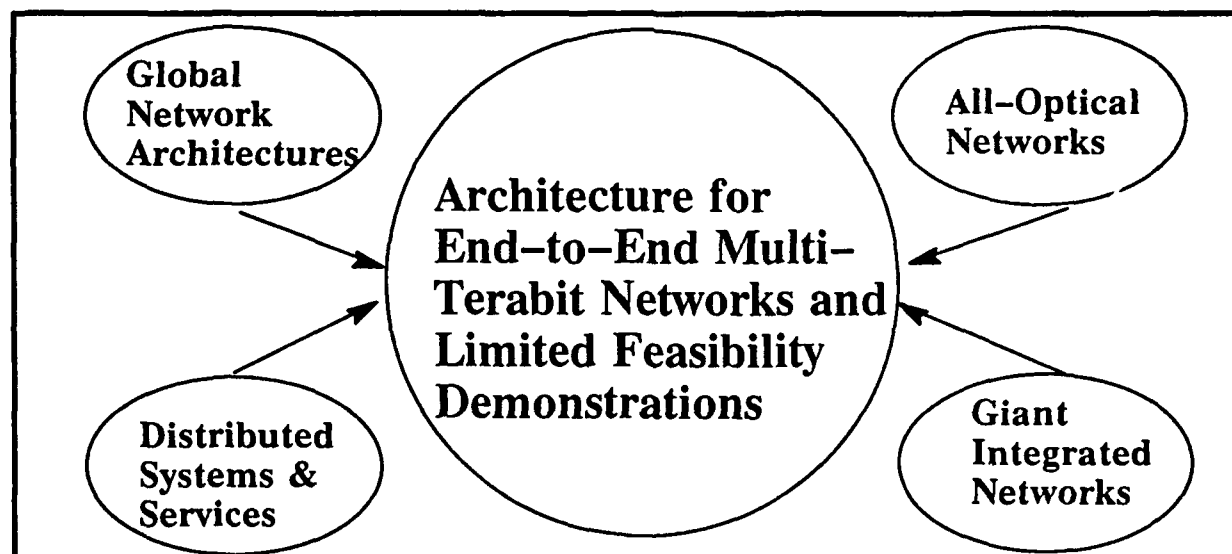
**POC:** Mr. Son Nguyen; (404) 894-3136

**CONTRACTOR:** Columbia University; Dr. Anthony S. Acampora

**OBJECTIVE:** The objective of this task is to use university-based research centers to provide windows into a variety of disciplines and leverage limited research funds.

**BASIS:** As ISC proceeds into the information age, it faces the major challenge of managing future integrated information networks characterized by high speed links (multi Gigabits/second transmission rates) which provide a full range of services among worldwide disparate users.

Membership in CTR allows AIRMICS to influence the direction of research conducted by the center, and, more importantly, to provide the Army with the most current information on appropriate technologies.



**APPROACH:** For an annual membership fee of \$10,000, AIRMICS gains access to more than \$5 millions worth of research. AIRMICS serves as the technology transfer vehicle to feed the center research results into other research projects being conducted by AIRMICS or directly into other elements of the command.

CTR is supported by the National Science Foundation (NSF) and more than twenty corporate sponsors. It is located at Columbia University, New York

City. Its goal is to identify and implement systems approaches for networks offering an aggregate capacity of several Terabits/sec. to be shared among thousands or millions of users through universal network ports operating at speeds of several Gigabits/sec. The center is pursuing a research program which stresses the theoretical, analytical, and experimental aspects of photonic telecommunications for networks characterized by multimedia transmission links such as coaxial cable, fiber optics and twisted pair. Research will focus on the integration and dynamic allocation of network resources which respond to multimedia traffic patterns, to include the unprecedented capacity required for transmission, routing, and processing of multimedia signals.

**ACCOMPLISHMENTS:** AIRMICS attended its first annual research review at the center on 25 October 1989. The center is concentrating on five areas: Networks, Analysis, VLSI, Lightwave Devices, and Software for Telecommunications; and three focal projects: Lightwave Network, Network Management, and Broadband Applications. CTR currently has an annual research budget up to five million dollars with 23 industrial members, mainly supported by the National Science Foundation.

AIRMICS has obtained 62 technical reports from the center. These reports cover a variety of topics which relate to Lightwave Networks, Network Management, and Broadband Services and Applications. For more information see the list of publications below.

**PLANS FOR NEXT QUARTER:** AIRMICS will participate in an annual research review at the center to be held in October 1990. During this review, AIRMICS will be assessing the assistance that the CTR can provide in the areas of software tools for Network Management Design and Network Distributed System Design. Any tools identified can be utilized by AIRMICS or by any elements of the command.

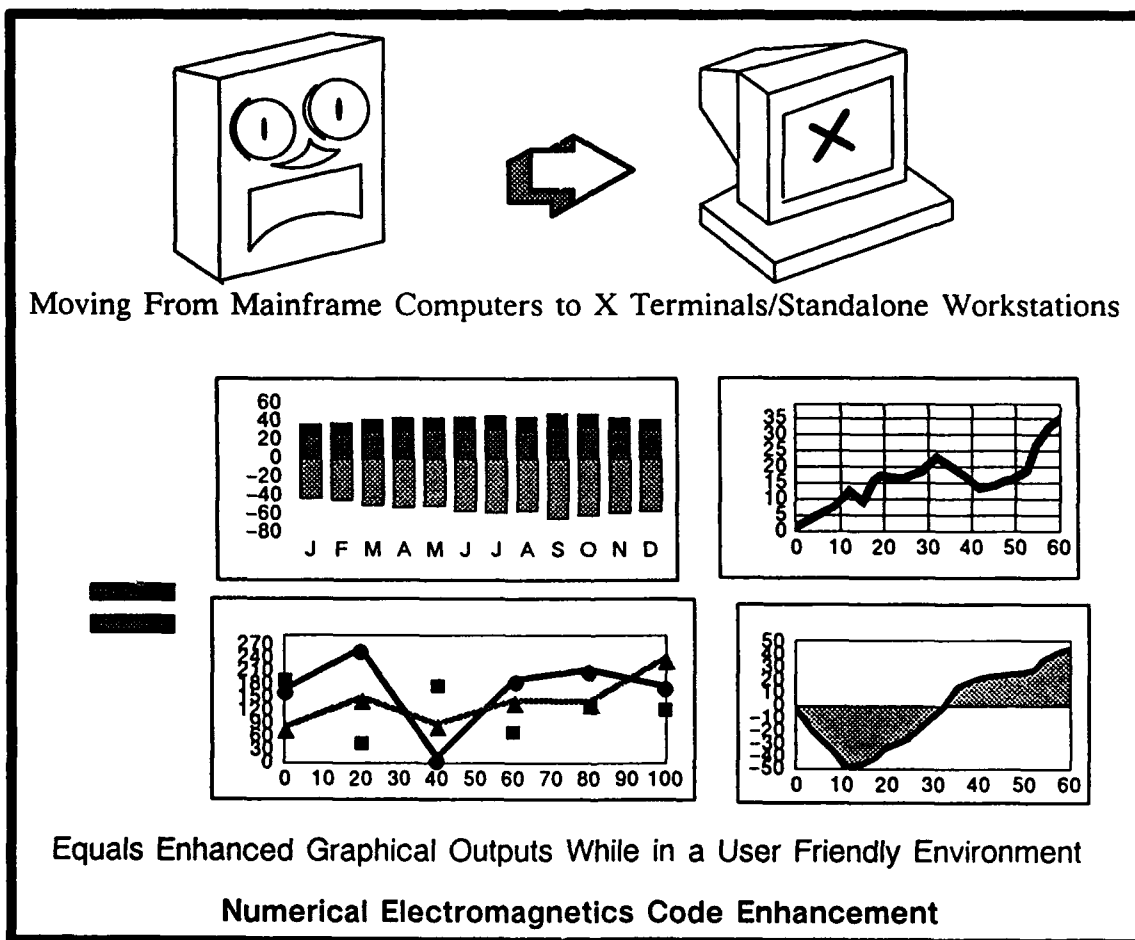
**PUBLISHED REPORTS:** There are numerous reports from this center. For electronic copies of abstracts or paper copies of the reports, please contact Dr. Jay Gowens.

c. **TITLE: NEC Enhancement; HF Design System**

POC: CPT Tim O'Hara; (404) 894-3136

CONTRACTOR: In-House

**OBJECTIVE:** To implement a large antenna modeling program, Numerical Electromagnetics Code (NEC), on a Sun 386i and Sun SPARCstation. To design pre- and postprocessors that will make the code more "user friendly" and integrate these into an easy-to-use antenna modeling tool.



**BASIS:** NEC uses complex numerical integrations and very large matrices to solve the required design equations. This computational requirement has in the past required a large mainframe computer resulting in the researchers using the program late at night (i.e. midnight) and long processing delays (mainframes share resources to all terminals). Recent advancements with workstations has made the implementation of NEC on a workstation an

inexpensive option for antenna analysis. This project will use the latest Sun Fortran compiler (ver 1.3) and will implement and evaluate NEC's Fortran source code on a Sun 386i and Sun SPARCstation. An additional complaint about the current version of NEC is that it is not easy to use. This project will also design pre- and postprocessors in order to make the program more user friendly and much easier to implement.

**APPROACH:** The initial problem is to successfully implement the current version of NEC on a Sun 386i and Sun SPARCstation. Once implemented, the next task is to design a preprocessor and postprocessor in order to facilitate inputting and outputting data to the program. Currently the version of NEC is very "user unfriendly" and requires a high degree of experience to run the program. The final task is to incorporate the pre- and postprocessors into one integrated package using Suntools (Sun windowing environment). This will improve the ability to create NEC input models and obtain NEC generated data.

**ACCOMPLISHMENTS:** Initial contact with representatives of the Transmission Systems Division of the Spectrum Engineering Branch, ISEC, resulted in a rough outline of the pre- and postprocessor requirements.

NEC3 and NEC4 have been successfully ported to a Sun 386i and a Sun SPARCstation.

A prototype graphical user interface for NEC3 and NEC4 has been designed and written using the Sun Suntools window environment.

**PLANS FOR NEXT QUARTER:** A trip is planned in early November 1990 to Fort Huachuca to demonstrate the current state of the software prototype. This includes the NEC 3 and NEC 4 functionality as well as the user interface which was designed and programmed last quarter. The demonstration will be given to representatives of the Transmission Systems Division, SED, ISEC. The next step is to port NEC3 and NEC4 to a IBM RISC workstation and to convert the graphical interface from Suntools to X windowing environment.

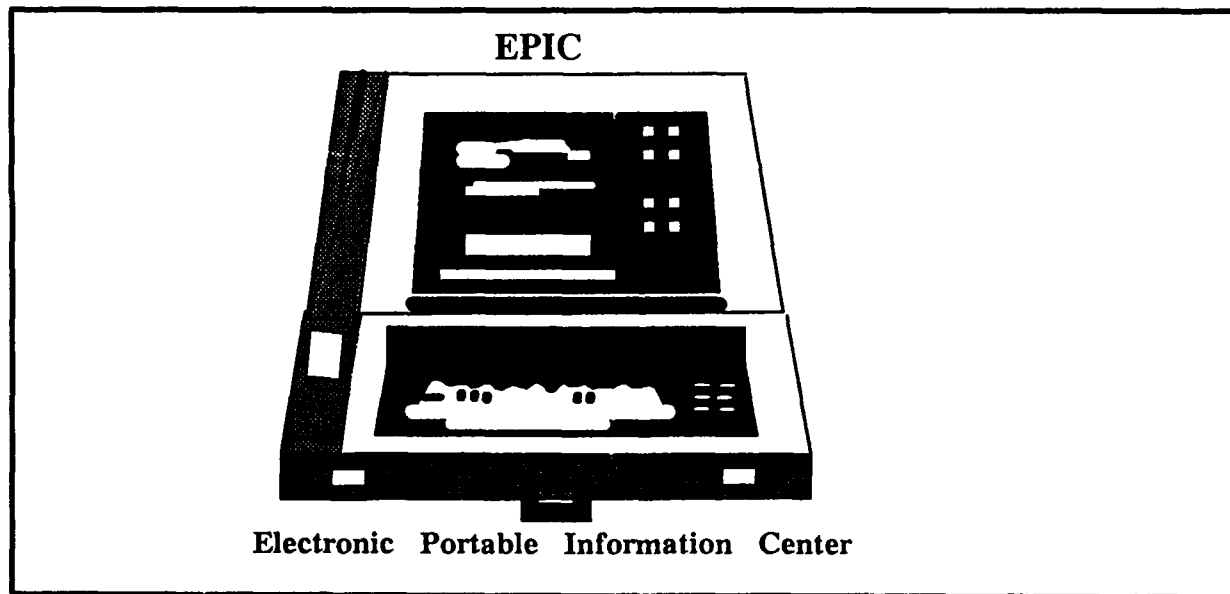
**d. TITLE: Evaluation of a Portable Executive Management Computer**

POC: Adrienne Raglin; (404) 894-3136

CONTRACTOR: In-house

OBJECTIVE: To become familiar with the new voice-data terminal technology, to develop applications for this technology, and to transfer this technology to the Army senior executive level.

BASIS: This project provides six senior Army officers with the Electronic Portable Information Center (EPIC) and user-friendly software to determine the feasibility of these units for providing an improved capability to send, receive, and process data information via the cellular telephone system. The project will identify the concepts, procedures, and requirements for further development of an Executive Management System.



APPROACH: For this project, PEO Strategic Information Systems has selected the EPIC manufactured by ANALYTICS of Fairfax, VA, as the prototype hardware for development of an Executive Management System.

AIRMICS, in conjunction with the General Purpose Computer Support Center (GPCSC) and PEO Strategic Information Systems, has fielded four EPICs and selected software to senior Army executives for evaluation. The prototype system will also be given to:

CG TRADOC  
CG FORSCOM  
CG JTC3A  
PM ISMA

CG XVIII Airborne Corps, Fort Bragg  
AIRMICS  
GPCSC  
USAISSC

The evaluation will be run by AIRMICS over a one-year period.

ACCOMPLISHMENTS: The initial planning and training meeting was held on 9 June 1988 to familiarize participants with the hardware and software being used for the evaluation.

The EPIC Evaluation Letter of Instruction (LOI) for the conduct of the evaluation was published on 8 July 1988.

The EPIC Phase 1 Review was held on 13 September 1988 at the GPCSC in Washington, DC. The review generated information on the usefulness of the EPIC and various deployment configurations/scenarios within the Army.

The hard disk version of the EPIC arrived in May 1989.

The initial evaluation to Mr. Robert Chin giving a summary of the users comments was provided in September 1989.

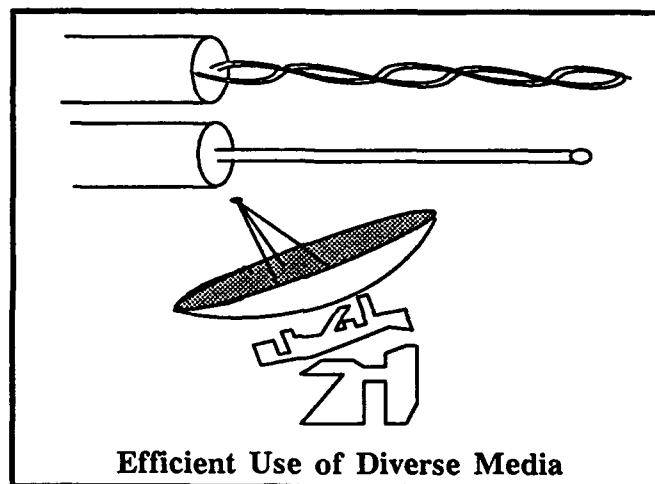
The final evaluation paper was submitted February 1990 to Mr. Robert Chin. With the submission of this final report the project completed all of its objectives. The project was ended in September 1990.

**e. TITLE: Multimedia Network Design Study**

**POC:** CPT Tim O'Hara; (404) 894-3136

**CONTRACTOR:** Harris Corporation; Dr. John Doner

**OBJECTIVE:** The objective of this project is to provide new analysis tools and techniques specifically developed for the analysis of multimedia, multimission networks. Multimedia networks may incorporate coaxial cable, fiber optics, twisted pair, etc.; and a mission may involve a set of financial transactions, or a teleconference. The work will focus on the optimization of media selection relative to traffic types, and the measurement of multimedia, multimission networks.



**BASIS:** The increasing need for efficient interconnection of the Army communications systems such as DDN, DSN, AUTOVON, and Post or local area networks, requires that systems be evaluated as a group as opposed to an individual level. This is particularly important to ISEC, which will in the future, be engineering an advanced information systems architecture which will contain fiber optics, coaxial cable, and twisted pair networks. In addition, ISC is involved with the interoperability of HF and LF radio equipment and with interfacing this equipment with conventional networks. In general, the interconnected networks involve a range of media and traffic types, all of which must be considered when the design of the interconnected network is being configured. This project will provide tutorials and design tools for developing and maintaining multimedia, multimission networks.

**APPROACH:** The first stage of this project will be a survey of the Army strategic network and plans, and a taxonomy of the media and traffic types.

From this data, a steady-state network model will be developed and analyzed. The next stage will incorporate adaptive routing, flow control, and network management algorithms on a representative network model. In the final stage, network performance and mission-oriented metrics will be developed. Throughout the project, all results will be transferred to ISEC-SED and other interested agencies for use in enhancing the existing communications systems.

**ACCOMPLISHMENTS:** This project began in August 1988 and was expected to end in August 1991. During the second quarter of FY88, Harris presented a proposal and briefed AIRMICS on Multimedia Network Design efforts and other related areas of research. An academic review of the proposal was conducted during the third quarter of FY88, and the response was very favorable for funding this work. During the same time frame, technical liaisons within ISEC-SAO, ISEC-SED, and PEO Strategic Information Systems (SIS) were established.

An initial program meeting was held during the first quarter of 1989 in order to provide an overview of the project to ISEC-SED, ISEC-SAO, CECOM, and PEO SIS; and to discuss the initial stages of the project.

Harris began to formulate a model of the Multi-Media Communications Process involving the characteristics of the media and the traffic.

An IPR was held on 20 April 1989. The PI gave an overview of the project, and went into detail on the proposed modeling effort.

A meeting was held between representatives of the Concepts and Studies Division of the Directorate of Combat Developments (DCD) SIGCEN; the Government Systems Division of Harris Corporation; and AIRMICS to discuss current modeling efforts. This meeting helped to coordinate present and future Army communications systems modeling and simulation efforts.

Delivery of a closed-form analytical queuing model for networks of queues (MMDESIGN), which included the delivery of software and the First Year Final Report, was accomplished in November 1989.

Due to budget constraints placed on AIRMICS for FY 90, this project was terminated on 5 March 1990. A final IPR was held on 22 February 1990. An enhanced version of MMDESIGN was delivered at the IPR. Any future work in this area will be conducted on a new contract.

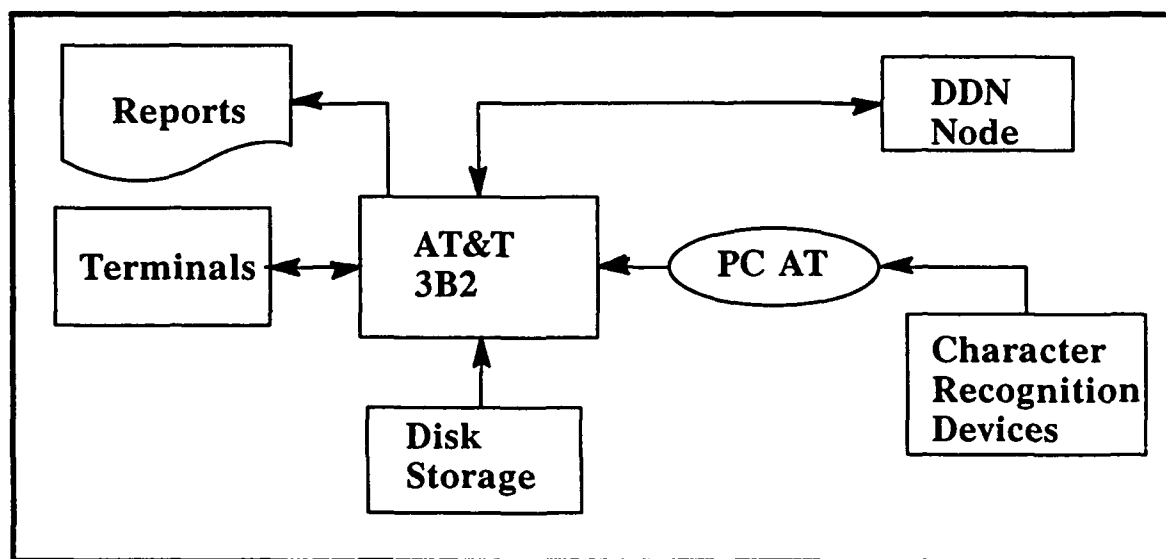
**f. TITLE: Master Schedule of Activities (MASSCHACT) Prototype**

POC: Dr. J.W. Gowens; (404) 894-3136

CONTRACTOR: Georgia Institute of Technology; Ms. Kit Kamper

**OBJECTIVE:** This task will design a master schedule of Activities which will provide support to the Directorate of Ceremonies and Special Events for the Military District of Washington (MDW) for scheduling assets for events in the Washington area. The system will use innovative technology to meet the unique requirements of this Directorate. The system will be designed so that it can be encapsulated into the Installation Support Modules (ISM) project.

**BASIS:** The Directorate of Ceremonies and Special Events serves as the principle MDW staff section for ceremonies and special events. They function as an operating agent for the White House, Department of State, Department of Defense, and Department of the Army in matters pertaining to the planning, coordination, direction, and conduct of official ceremonies in the Nation's Capitol and at other designated locations within the United States, as required.



Scheduling and coordination of events in the MDW is a fast paced activity which requires perfect performance at every event. The Directorate must schedule and coordinate events from the lawn of the White House to funerals at Arlington National Cemetery to wreath laying ceremonies at the Tomb of the Unknown Soldier. Because the assets must travel between events and

there is a large volume of events, Scheduling of the assets must be done carefully. This system will assist the directorate in this scheduling.

**APPROACH:** A database tool will be developed using Informix to support the MASSCHACT requirements. The tool will be a Decision Support System (DSS) to assist planers in the three divisions of the Directorate with scheduling, allocation of resources, storage/retrieval of schedules, and other reporting procedures.

MASSCHACT will provide the capability to correlate hardware, software, and interfaces, both logical and physical. The tool will provide the capability of combining data from a variety of electronic sources as well as manually entered data. It will provide the capability to perform predefined queries and generate formatted reports as well as the ability to perform ad hoc queries and general reports. It will provide simple statistical calculations required in the generation of reports (e.g. column sub-totals and totals, row totals). The system will be capable of producing the reports on active files, archived files and combined active and archived files.

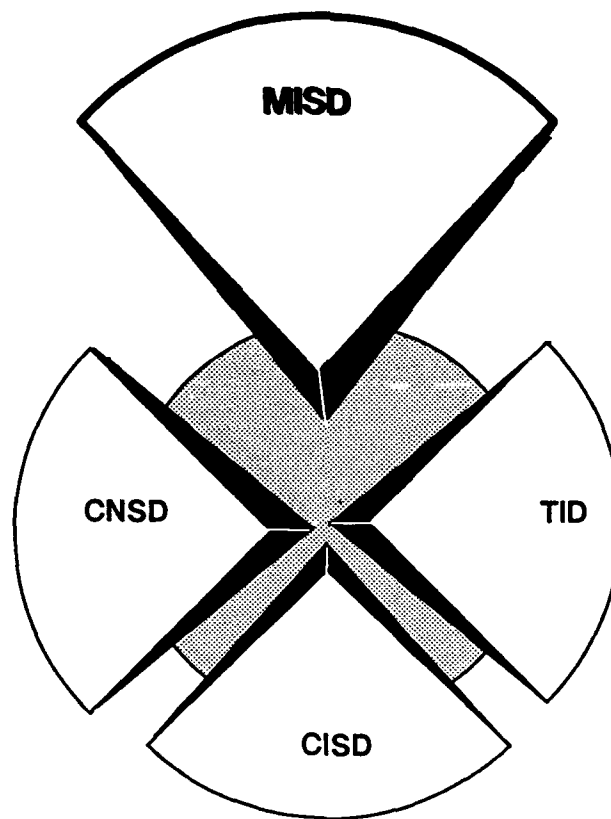
**ACCOMPLISHMENTS:** The contract was awarded on 15 August 1990. Hardware items have been placed on order and the Informix software has been delivered and installed. Programming of the initial prototype has been initiated.

**PLANS FOR NEXT QUARTER:** A demonstration of the initial prototype is planned for 8 November and another on 3 December 1990. Both of these demonstrations will be integrated with the Installation Level Integrated Database (ILIDB) being developed by PM-ISM.

#### **D. MANAGEMENT INFORMATION SYSTEMS DIVISION (MISD)**

MISD performs research in Decision Support and Management of Information.

In the Decision Support area, MISD develops techniques and methods to improve the quantity and quality of information to support decision making. We group MISD's current efforts in four general categories: Individual Support, Group Support, Executive Support, and Expert Support. This research closely relates to the target architectures developed by ISC where ISC lists Decision and Executive support as basic services to be supported by command developed information systems. This research supports work performed by PMs, engineers and architects of Army information systems.



In the Management of Information area, MISD develops concepts to support the use of technology in the management and operations of information intensive segments of the Army. This research area brings together several diverse projects. These projects include research on the evolution of Information Centers (IC) to support the entire Information Mission Area (IMA), membership in the Center for Information Management Research at

the Georgia Institute of Technology and the University of Arizona, a video teleconferencing network to support communication between Historically Black Colleges and Universities (HBCUs) and the Army. This research supports actions in ISC-DCSPLANS, ISEC-PID, ISEC-SID, and the 7th Signal Command.

MISD continues support to NATO, ASA (RDA), DISC4, ISC-DCSPLANS, ISC-DCSOPS, PM AIM/DAIN, PM ISM, ISEC-SID, ISEC-SED, ISEC-PID, 7th Signal Command, HQDA Artificial Intelligence Center, FORSCOM, PERSINSCOM, and the Defense Systems Management College (DSMC) through research efforts aimed at providing answers to questions important to these organizations.

The Army Acquisition Management System (AAMS) project supports PM AIM/DAIN for ASA (RDA) by expansion of earlier work on the AAMS prototype. This effort extends the prototype to over 40 PM shops under ASA (RDA). This project supports AIRMICS research efforts in Executive Information Systems and is coordinated with ISEC-SED.

MISD's research into the integration of support for the IMA into the functioning of the Information Center (IC) continued. The final product, "The Integrated IMA IC Guide," was delivered in June 1990 and will be distributed Army-wide. MISD also started a new IC project to explore automated tools to support the IC. The first phase of this research developed a prototype automated "Help Desk" function to assist the IC in answering routine questions about the IMA.

The AIRMICS pilot video teleconferencing (VTC) network, being installed as part of the CARTS project with Clark Atlanta University, was demonstrated to, and used by, a wide variety of people during the year. The ASA (RDA), PERSINSCOM, and the U.S. Navy funded this project and it is supported by the DA SADB, DISC4, ISC-DCSPLANS, and ISEC-PID. The effort examines the uses and the economics of low cost VTC. Additionally, the project establishes closer links between the Army and Historically Black Colleges and Universities (HBCUs). Network sites operate at Fort Huachuca, Fort Belvoir, PERSINSCOM, AIRMICS, the U.S. Naval Surface Weapons Center, Clark Atlanta University and Prairie View A&M.

If you are interested in any of the above areas that are discussed in this Research Status Report, or have questions relating to MISD, please contact Dr. Jim Gantt, e-mail address [gantt%airmics@gatech.edu](mailto:gantt%airmics@gatech.edu), phone (404) 894-3107.

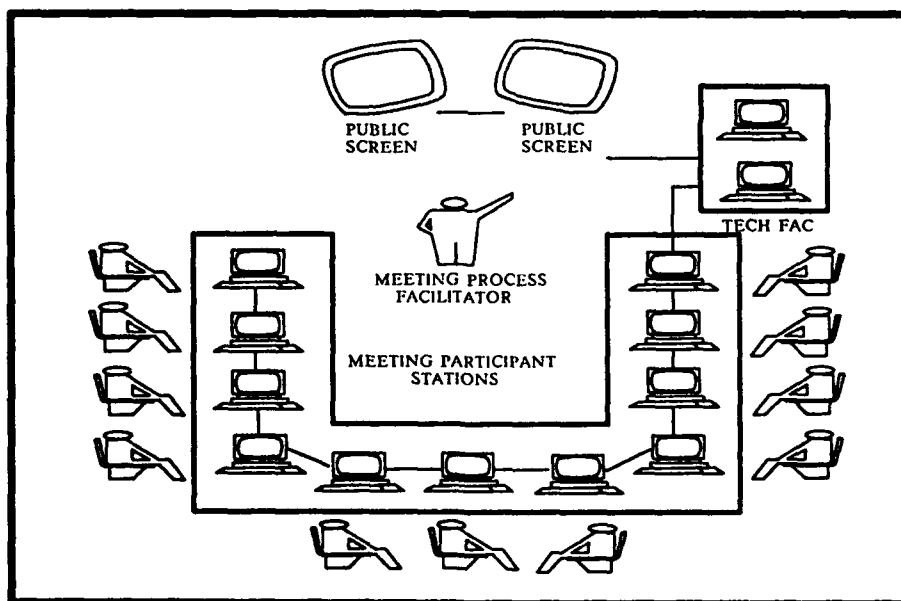
## 1. DECISION SUPPORT RESEARCH

### a. TITLE: Application of Electronic Meetings to Support System Requirements Definition

POC: Major (P) Mike Mizell; (404) 894-3107

CONTRACTOR: University of Arizona; Dr. Jay Nunamaker

OBJECTIVE: To perform an analysis of basic information needs of military installations during everyday operations to develop installation support modules (ISM) that have the potential to enhance overall installation performance. To accomplish these processes, Requirements Analysis Processing (RAP) will be used to address already identified key elements that fall into one of the following areas: 1) plan requirements; 2) direct resources; 3) acquire personnel; 4) acquire property and resources; 5) support personnel services; 6) support property; and 7) monitor activities.



BASIS: AIRMICS has been working with the University of Arizona for the past five years on the development of electronic meeting tools that will enhance the Army's capabilities to perform its diversity of missions in a more professional, timely and cost efficient manner. In late fall of 1989, PM-ISM approached AIRMICS to determine if there were processes/procedures/research efforts ongoing or completed that could be used to enhance the developmental processes of the ISM program. A nine week

**b. TITLE: Visual Knowledge**

POC: Dr. Michael Evans; (404) 894-3107

CONTRACTOR: BDM Corporation; Dr. Tamra Hall

**OBJECTIVE:** The objective of this research is to investigate methods of knowledge representation and elicitation to improve computer manipulation and presentation of visual knowledge. This research will produce a prototype interface addressing this need that facilitates direct pictorial communication between user and machine. While the initial focus is on tactical planning, it is felt that the results can be applied to more general problems in the Information Mission Area (IMA). Funding for this project was provided by LABCOM.

**HUMAN REPRESENTATION**

- \* Governs the way people describe experiences
- \* Influences how people conceptualize visual information
- \* Determines ease of mental operation on visual information

**MACHINE REPRESENTATION**

- \* Must be suitable for techniques used in programs
- \* Constrained by software engineering and knowledge engineering considerations

**INTERFACE**

- \* Must be compatible with input devices
- \* Must allow reconstruction for output purposes
- \* Must be compatible with machine representation

**REPRESENTATIONS OF VISUAL KNOWLEDGE**

**BASIS:** The development of better representation and elicitation methods for visual knowledge is of value in several areas:

- \* Visual images are central to reconnaissance and surveillance
- \* Within command and control, visual displays and visual input systems are of major interest
- \* In coupling maps with computers, as in terrain databases there are problems with representation of visual knowledge
- \* Visual representation is an important factor in battle management training

**APPROACH:** This research will be conducted in three phases:

RAP session had been concluded which defined and focused Army attention on individual installation processes identified as 1 thru 7 above, which needed to be analyzed, defined and developed in depth.

**APPROACH:** Subject matter experts (SMEs) from all major commands (MACOMs) will be used to address these issues with the intention of identifying all data elements, critical success factors, processes and finally, a functional descriptive document, generically "green" enough to support operations at all Army installations. Considerations will be given to specific requirements relative to different types of activities; however, this major focus is towards like-type activities and processes common to all.

**ACCOMPLISHMENTS:** Several sessions have already been completed (five sessions covering seven weeks), all of which have been very successful in accomplishing specified objectives, identifying data element listings, processes tied to the data elements, and providing in-depth functional description documents which can be used "generically" to support these functions at any Army installation. The remaining planning sessions have tentatively been scheduled and are required to further the identification of those improvement opportunities for the integration into installation information sharing applications.

**PLANS FOR NEXT QUARTER:** Two additional sessions are planned for the first quarter of FY91.

**PUBLISHED REPORT:**

Functional descriptions have been published. Information on the reports or copies can be obtained by contacting: HQDA-DSMA, ATTN: CSDS-CS, Pentagon, Room 3D-621, Washington, DC 20310

PHASE I – Knowledge Acquisition and Cognitive Modeling. This phase will focus on gathering the information, knowledge, and processes involved. The result of this phase will be a cognitive model that is accurate with respect to the content of the knowledge.

PHASE II – Functional Design of User Interface/Knowledge Representation of Interface. The focus of this phase will be on the appearance, functions, and input/output behavior of a prototypical user interface for intelligent aids for tactical planning.

PHASE III – Prototype Implementation. The focus of this phase will be on implementation of the design of the first two phases into a proof-of-concept prototype interface.

ACCOMPLISHMENTS: Phase I of this research was completed in April 1990. A technical report on the results of the Phase I effort was completed.

PLANS FOR NEXT QUARTER: The research for the next quarter will focus on knowledge acquisition and cognitive modeling. A statement of the functional capabilities needed by a user interface supporting visual reasoning will be developed.

#### PUBLISHED REPORT:

Lancaster, J., "Visual Knowledge in Tactical Planning: Preliminary Knowledge Acquisition Phase I Technical Report," BDM Corporation, April 1990.

The work described in this report focuses on the non-verbal components of knowledge used in a map-based planning task. This phase of the project involved knowledge acquisition activities oriented toward identifying the visual objects and features of objects that are of tactical importance. The project has completed the following tasks:

- \* Identified a set of terrain objects and their features that are critical in tactical considerations;

- \* Identified a set of map characteristics that inform the perceiver about the terrain objects and their features;

- \* Identified a set of composite terrain features that are important in tactical planning; and

- \* Captured substantial evidence of the type of reasoning applied to visual information during tactical planning.

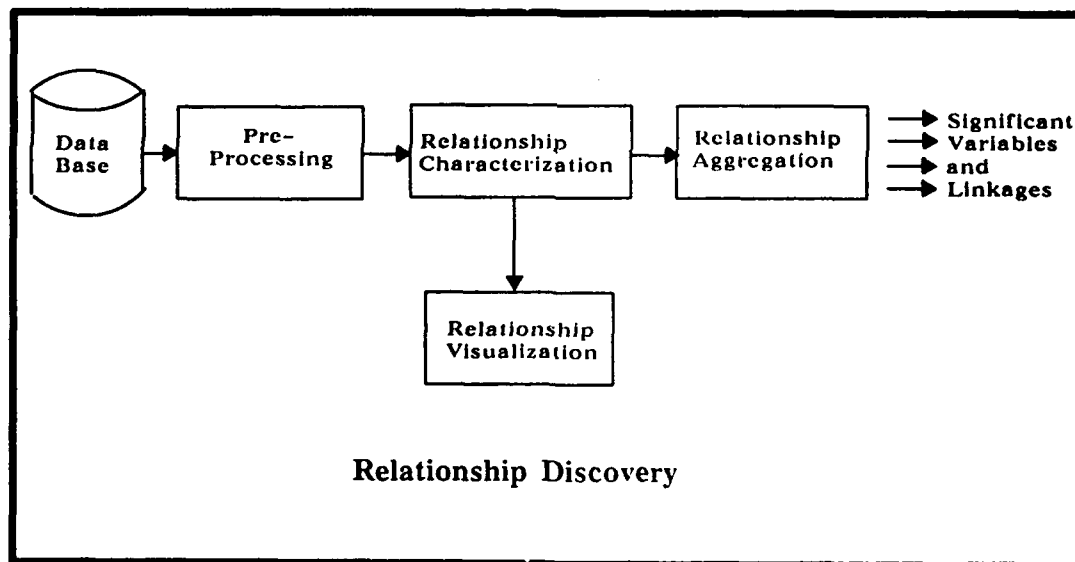
**c. TITLE: Application of Neural Networks for the Extraction and Characterization of Knowledge Contained in Databases**

POC: Major (P) Mike Mizell; (404) 894-3107

CONTRACTOR: HNC, Inc.; Mr. William Caid

OBJECTIVE: This effort will develop the ability to characterize, extract, and exploit knowledge contained within databases using neural network techniques. Development of this capability will give military decision-makers a powerful tool for the analysis of data found in large databases.

BASIS: Large databases exist for use by military commanders and executive decision-makers. Conventional technology does not easily allow the extraction or distillation of the knowledge contained within these databases. As a consequence, the true power of this information is inefficiently utilized.



APPROACH: This project is funded under the DOD Small Business Innovation Research (SBIR) program for a phase I effort. Phase I will take capabilities demonstrated on commercial sector databases, called "Knowledge Extraction using Neural Networks" or KENN, and extend the ability to discover unknown relationships contained in the databases. The most powerful component of KENN, Relationship Discovery, has only been demonstrated on a proof-of-concept basis. This effort will enhance the Relationship Discovery component of KENN with specific emphasis to Army Executive Information Systems.

ACCOMPLISHMENTS: The contract for this project was awarded in September 1990 and will run for 6 months.

PLANS FOR NEXT QUARTER: An IPR will be held in December and there will be an interim report presented at the same time.

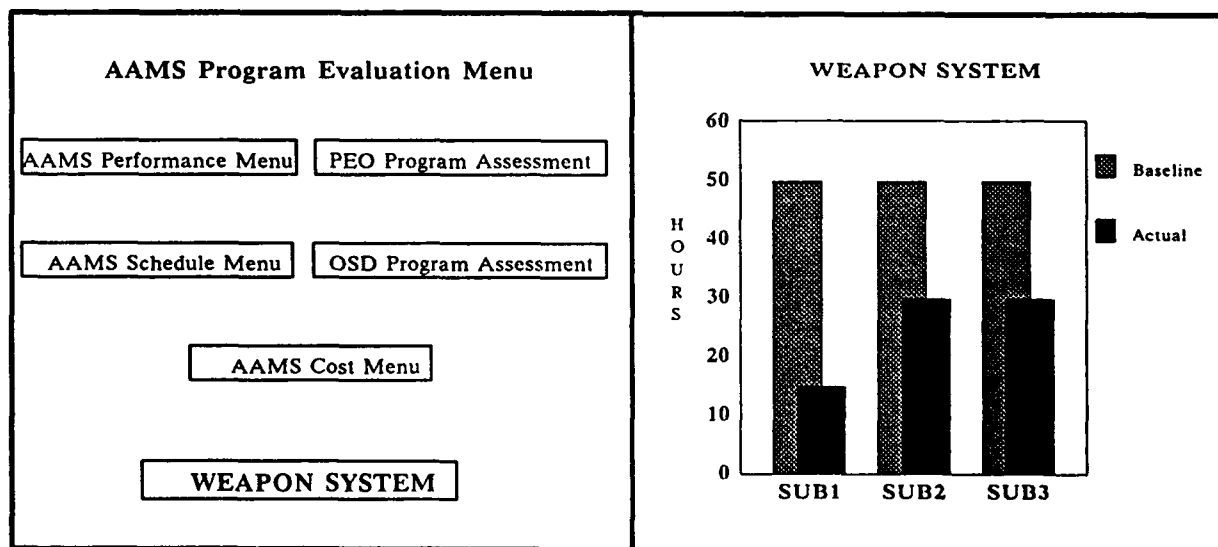
**d. TITLE: Army Acquisition Management System (AAMS) Prototype**

POC: Dr. Michael Evans; (404) 894-3107

CONTRACTOR: Office of the Future, Inc.; Dr. James Carlisle

**OBJECTIVE:** The objective of this research effort is to improve the effectiveness of oversight and decision making by the Army Acquisition Executive (AAE). A prototype of the AAMS will be developed and tested. This project will explore issues relating to executive information systems and then apply the concepts to the AAMS system. The prototype will impact the Acquisition Information System (AIS) and be PC-based.

**BASIS:** Implementation of the Goldwater-Nichols Act created the Army Acquisition Executive and the supporting structure which includes the Program Executive Officers (PEOs) and the Program/Project Managers (PMs). Since most of these relationships are new, and the support structure does not yet exist, a unique opportunity is available to AIRMICS. This situation will allow AIRMICS to take part in the development and implementation of one of the Army's few executive information systems.



**APPROACH:** The approach to be taken in this project is to develop and test a prototype Executive Information System for use by the AAE, PEOs, and PMs. This project will be divided into three phases. In the first phase, a prototype PC-based system will be designed and implemented with functional capabilities for data collection, chart definition and selective display of charts and explanatory text. In the second phase, the prototype will be implemented

in two PM AIM/DAIN testbed sites (PEO STAMIS and PEO CS and their PMs). The purpose of this implementation is to evaluate, refine, and enhance the design concepts developed in the first phase. In the third phase, the prototype will be extended to address the integration of a multi-tier relational data base architecture, the DSS capabilities will be enhanced, and the prototype AAMS will be institutionalized. This work is coordinated with ISEC-SED.

**ACCOMPLISHMENTS:** The first phase of this project was awarded in January 1987 and has been completed. The second phase was awarded in July 1988 for a period of one year. The third phase was awarded 1 August 1989 and will be completed by 31 December 1990. The current prototype is being used by ten PEOs and thirty PMs.

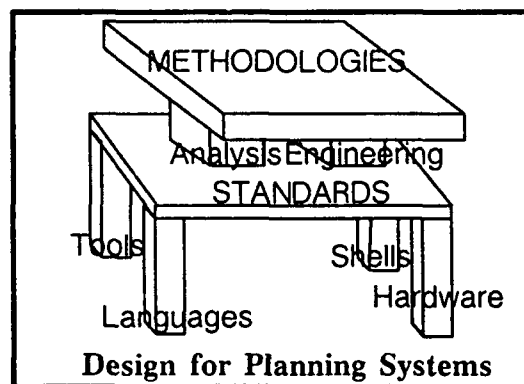
**PLANS FOR NEXT QUARTER:** The final changes to the Phase III software will be completed.

**e. TITLE: Design of Expert DSS Methodologies for Problem Solving under Uncertainty**

POC: Dr. Michael Evans; (404) 894-3110

CONTRACTOR: University of California, San Diego; Dr. Dave Kirsch

OBJECTIVE: Develop and demonstrate a design methodology for developing Expert Decision Support Systems for solving problems under conditions of uncertainty.



**BASIS:** Recent advances in the application of artificial intelligence methods to Decision Support System models have opened the way to the development of automated decision support tools that are applicable to problem domains and conditions of increasing uncertainty. Under a conventional problem solving model, the developer requires the entire environment (all constraints and goals) to be known in each iteration of the problem solving process. By applying an artificial intelligence (AI) based model, the “optimizing” approach can, for some problem domains, be substituted for a heuristically driven “satisficing” approach with satisfactory results. The incomplete nature of most problem solving domains contributes significantly to the potential for these models, particularly in light of the exponential impact that increased numbers of alternatives (symptomatic of the “optimizing” effort) have upon traditional models.

**APPROACH:** This research will address the problem domain of planning, with a focus on resource management. The effort proposes to cope with incomplete knowledge and uncertainty in the planning process by controlling resources necessary to accomplish the goals. Resources are the limiting factor

in the process of selection of appropriate actions to attain a desired goal-state (either intermediate or ultimate goal). If the planning system determines the resources sufficient to achieve a goal, heuristics can be employed at run-time to determine appropriate action. This research is funded by the HQDA Artificial Intelligence Center.

**ACCOMPLISHMENTS:** The first phase of this project was awarded 4th quarter FY88. The initial IPR was conducted at MIT in the 3rd quarter FY89. The results of this research could impact a wide variety of Army planning environments, especially project management. An IPR was held at the UCSD in July; a demonstration of software to aid in problem solving under uncertainty was given.

The initial phase of this research was completed in August 1989. The final option year was exercised in September 1989 and will continue until September 1991.

**PLANS FOR NEXT QUARTER:** Research for the next quarter will continue developing a theory of resource planning which does not rely on complete models.

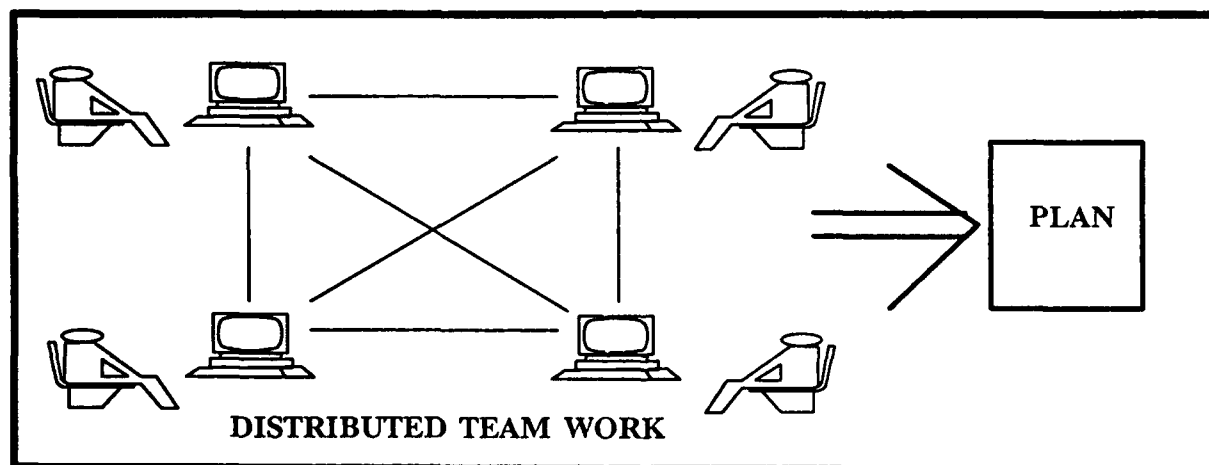
**f. TITLE: Distributed Computer Supported Team Work**

POC: Dr. James Gantt; (404) 894-3107

CONTRACTOR: Georgia Institute of Technology; Dr. Charles Parsons

**OBJECTIVE:** The objective of this research is to apply distributed computer supported team work concepts to realistic Army problems. This research will investigate how distributed groups use computer and communications technology to accomplish their work.

**BASIS:** Increasingly, team work occurs at all levels of the organization. And while considerable research has been done on team work in a decision room setting, this research will consider team work in the context of groups that are geographically separated. This research will be applied to problems common to the PEO, PM structure of the Army.



**APPROACH:** The approach to be taken is the following:

- \* Conduct experiments in distributed computer supported team work using a scenario from the PEO and PM structure
- \* Evaluate commercial groupware
- \* Develop and implement a research design to examine task type and group interaction technology in a laboratory setting
- \* Link a remote site to the laboratory to demonstrate feasibility of linking remote offices

**ACCOMPLISHMENTS:** The contract was awarded in July 1989 and ran through December 1989. Initial versions of a scenario were developed, implemented, and demonstrated on the commercial groupware.

PLANS FOR NEXT QUARTER: The project was completed in December 1989.

#### REPORT PUBLISHED:

Parsons, C., Nagao, D., "Final Report - Distributed Computer-Supported Team Work: A Research Paradigm," College of Management, Georgia Institute of Technology, December 1989.

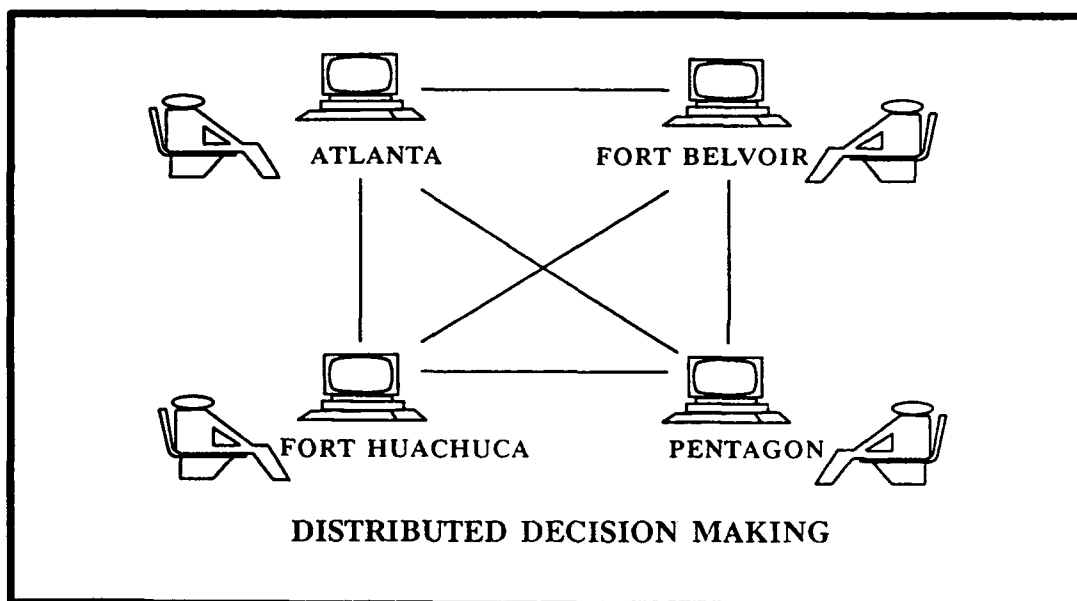
The purpose of the work outlined in this report is to develop, implement, and pilot test a research paradigm for systematically examining factors that may impact the effectiveness of computer-supported distributed team work. Within this general purpose, we had two goals. First, we wanted to establish a research setting where we could study the factors that lead to effective distributed computer-supported team work. Second, we wanted to investigate how, through the use of commercially available software and hardware, we could "patch-together" computers of different architectures and operating systems in order to facilitate computer-supported distributed groups working under varying systems.

**g. TITLE: Decision Making in a Geographically Distributed Environment**

POC: Dr. Michael Evans; (404) 894-3107

CONTRACTOR: Analytical Software, Inc.; Mr. Mark Haley

OBJECTIVE: The objective of this research is to create Group Decision Support System (GDSS) software that permits groups of decision makers to make decisions quickly, even when the decision makers are located around the world. The specific objectives will be to define the features that the GDSS model should include such as: (1) easy-to-use word processing, graphics, calendar, and databases; (2) state-of-the-art communications so that Army decision makers can be informed via fax, electronic mail, and paper mail; and (3) ability to collect comments, tabulate and rank votes and report the results to all of the decision makers.



BASIS: Most decisions in the Army require that teams of individuals work together. This includes the tasks of defining the problems, generating acceptable solutions, coordinating a decision from the possible solutions, and implementing the decision. Added to these group activities is the fact that the team members are often geographically distributed. This research will attempt to define those features that can best facilitate such group collaboration.

APPROACH: The approach to be taken is the following:

(1) **Define the features of the GDSS.** In general, the GDSS should permit any user to convey ideas easily and transmit information over a computer network. Key basic features are:

- \* Word processor
- \* File creation and storage
- \* Graphics capabilities including bar, pie, and line charts
- \* Calendar which can be shared
- \* Database capabilities
- \* Collect and summarize comments; vote and tabulation
- \* Communications which work on LANs and public networks

(2) **Develop and test the GDSS.** Several features would be added to make the software more useful including the ability to transfer any type of file. This will allow the transfer of files as diverse as word processing files to spreadsheet files to graphics files.

(3) **Test the software at Army sites.** Software will be installed and tested at four Army sites. The purpose of this test will be to define the GDSS features that are most useful to coordination of decisions in a geographically distributed environment.

**ACCOMPLISHMENTS:** This research began in June 1989 and resulted in a proof-of-concept prototype GDSS. PM ISM served as a test site to help define the GDSS features that would be most useful. If funded by the SBIR program office, the second phase should start in early FY91 and will develop the prototype into a fully functional GDSS. The prototype GDSS software was completed in November 1989.

**PLANS FOR NEXT QUARTER:** The funding for Phase II of the SBIR program will be determined.

**PUBLISHED REPORT:**

Haley, M., "Phase I Final Report - Decision Making in a Geographically Distributed Environment," Analytical Software, Inc., December 1989.

The purpose of this report is to describe the results of Phase I of this project. The report provides detailed information on the Group Decision Support software developed during Phase I.

DSMC and PM AIM/DAIN will receive the results of this research for use by their respective customers.

**ACCOMPLISHMENTS:** This research was done as an in-house project. A version of the system has been completed and delivered to DSMC for inclusion in their Program Managers Support System (PMSS). PMSS is being supported by PM AIM and the concepts of SARA will be incorporated into the integrated version of PMSS.

**PLANS FOR NEXT QUARTER:** This project was completed in July 1990.

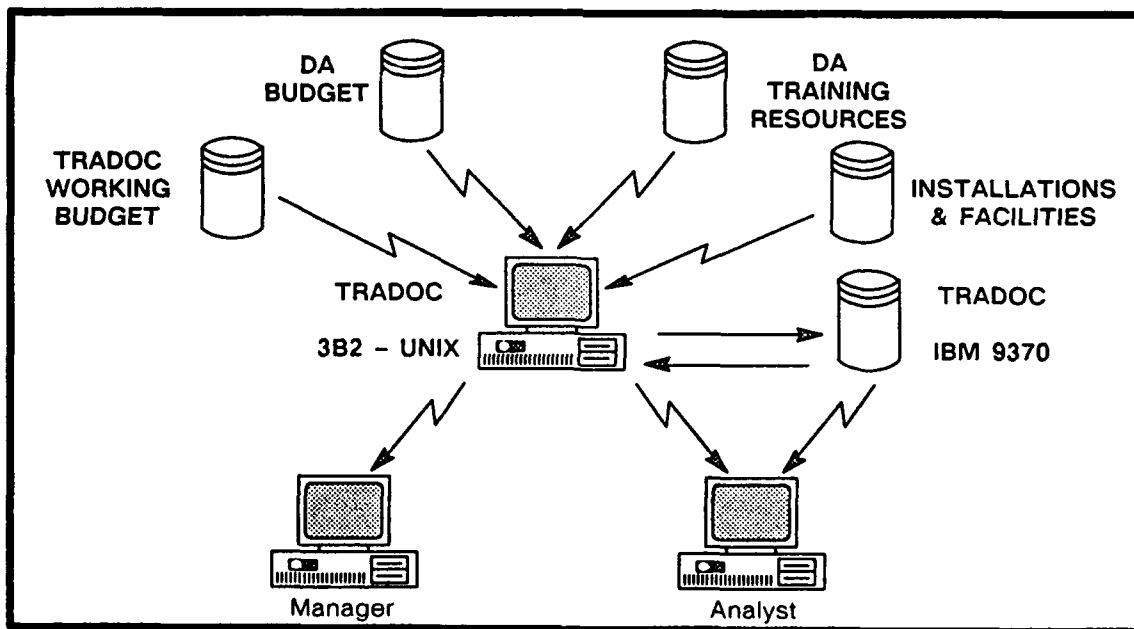
## 2. MANAGEMENT OF INFORMATION RESEARCH

### a. TITLE: Development of Rapid Prototyping and Development Capabilities at Historically Black Colleges and Universities

POC: Dr. Jerry McCoy; (404) 894-3107

CONTRACTOR: Georgia Tech, Morris Brown College, and Clark Atlanta University

OBJECTIVE: The objective of this project is to create within the Historically Black Colleges and Universities (HBCU) a resource capable of using AT&Ts Application Connectivity Environment (ACE) for rapid development of Army data processing systems. In the long run, we hope to have several schools trained to use ACE, but at first we will concentrate on one school which will then train several others. This project has two specific goals: to prototype a useful application for TRADOC, and to establish at Morris Brown College and Clark Atlanta University the capability to respond to the Army's need for rapid prototyping using ACE.



BASIS: The Army has computer applications and databases on a variety of computers worldwide. Many Army ADPE problems could be solved by integrating information from these systems. We need the ability to quickly create systems which integrate information from otherwise incompatible systems. USAISC headquarters has received many requests from the user

community for this type system. However, the traditional method for developing systems is too slow and too costly to meet this need. Moreover, much of the burden of traditional methods is justified by the need to insure accurate data collection. This need does not exist in the systems being discussed. They seek to use data that has already been collected, edited, and stored by larger systems.

**APPROACH:** The first application chosen for prototyping by Morris Brown and Clark Atlanta University using the AT&T product ACE is a TRADOC application called TRADOC Resource Manager's Information and Decision System - Test (TRMIDS-T). TRMIDS-T is designed to collect resource data from several different databases and to allow decision makers and their analysts to view, analyze and manage the data.

The prototype system will collect data from 4 different databases and consolidate it into flat files located at Fort Monroe. As the data is collected from the source databases, several tests are run on the new data to compare it against predefined rules/criteria. If any data fails to satisfy the criteria, an exception record is created and placed in a file.

The consolidated information will be accessed by senior managers for standard reports. Analysts will also have access to the standard reports, but will also move the collected data from the mainframe into PC applications for further drilling and analysis. Responsible analysts will be able to create additional exception records based upon off-line work.

The prototype will have two different modes: batch and interactive. In the batch mode, the application will collect data from 4 different systems (using predefined database queries) at set time intervals (weekly to quarterly), store the data in flat files, and then run the batch test algorithms against the newly collected data. The test algorithms will generate exception records which will be used in the standard reports to provide senior managers with quick summaries of the general trends in the data. In interactive mode, the application will provide menu-driven access to the data and exceptions stored in the consolidated files.

The file systems included in the TRMIDS-T system are: Customer Retrieval Service (CRS), a local program which selects data from several local mainframe files; On-Line Budget/POM, a system located at the Department of the Army (DA) in the Pentagon, which is accessed via the TRADOC mainframe network; The Army Training Resource & Requirements System

(ATTRRS), another DA mainframe database; and the Headquarters Installations & Facilities System (IFS), a database located on a commercial vendor's (McDonnell Douglas) machine and accessed via modem.

ACCOMPLISHMENTS: This project started in July 1990. Training in the ACE methodology was completed and TRMIDS-T was selected as the application to prototype. Extensive coordination with TRADOC has been done and the preparation for the prototyping completed.

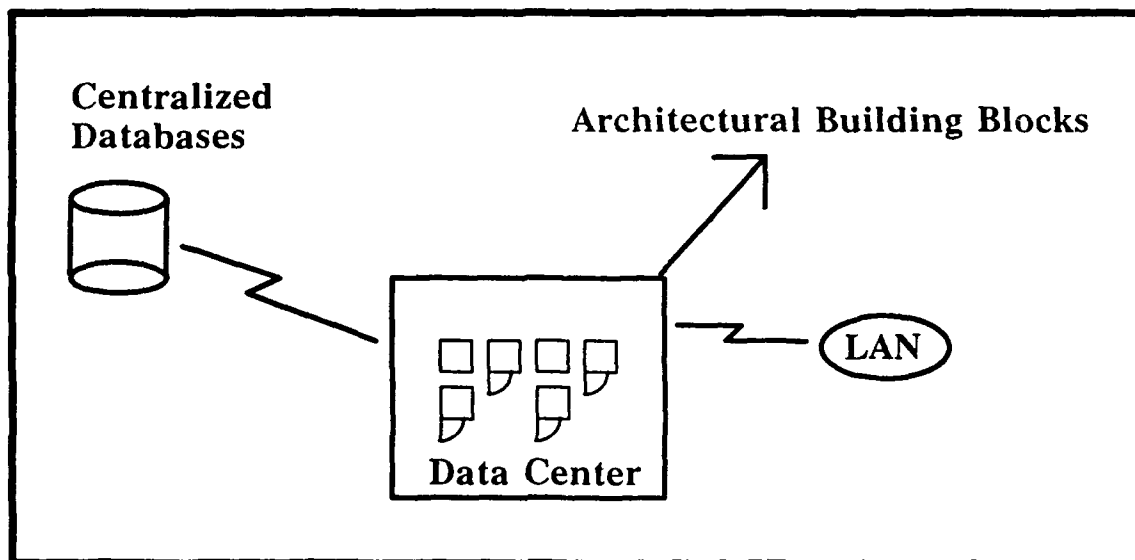
PLANS FOR NEXT QUARTER: Install ACE software and complete initial prototype. The initial prototype will be used to refine requirements and additional versions will be completed.

**b. TITLE: CAD for Information Management**

POC: Major (P) Mike Mizell; (404) 894-3107

CONTRACTOR: Georgia Tech; Mr. Mike McCracken

**OBJECTIVE:** This project will identify ways to improve decision making at multiple levels, dealing with data about automation and communications resources. This includes identification of the decisions, data needed to support the decisions, ways to present the data, and the combination of graphical and non-graphical data into one environment. The project will demonstrate the ability to collect data at a local level, using commercial PC-based software, and up-load the data to update a centralized database. In addition, it will demonstrate the ability to populate a local database from a centralized database.



**BASIS:** The combination of increased complexity of Army information systems and reduced budgets is putting pressure on Army managers to improve their decision making when dealing with data about automation and communications resources. It is not always clear what decisions are made, what data is needed to support the decisions, what ways should be used to present the data, or how to combine graphical and non-graphical data in one environment. Recent advances in PC-based Computer Aided Design (CAD) packages seem to provide a way to address the needs of representing graphical and non-graphical data in the same information environment.

APPROACH: Building upon the data platform which can be created in a CAD environment, it should be practical to demonstrate the ability to collect data at a local level, using commercial PC-based software, and up-load the data to update a centralized database. It is also necessary to demonstrate the ability to populate a local database from a centralized database. With this foundation it would be possible to develop methods to visualize the relationships between various architectural building blocks (Geographic/Technical Architecture, Applications Architectures, Data Architectures, and Information Models).

ACCOMPLISHMENTS: This project was started in September 1990.

PLANS FOR NEXT QUARTER: The CAD software will be selected and purchased. Initial installation of the CAD package will be at Fort McPherson and AIRMICS. The initial data base will be created for both locations and preliminary work done on the architectural building blocks.

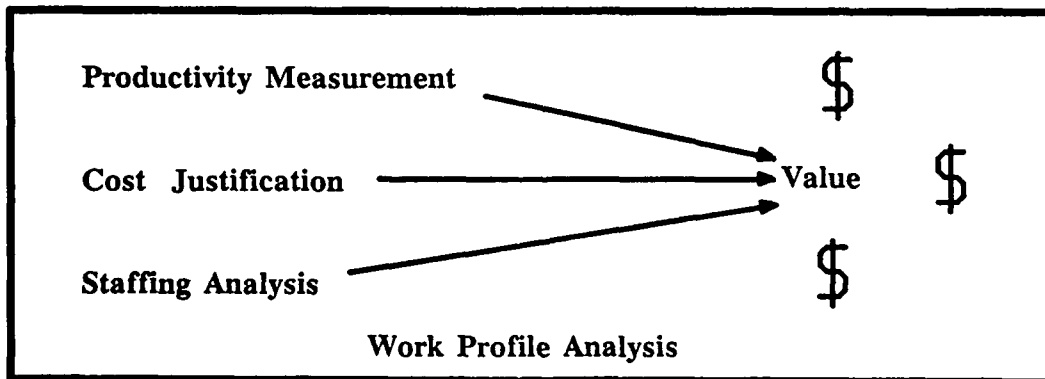
c. **TITLE: Economic Justification of Information Systems**

POC: Major (P) Mike Mizell; (404) 894-3107

CONTRACTOR: Georgia Tech; Dr. Peter Sassone

**OBJECTIVE:** This project will develop a baseline work profile study of two or more offices prior to the implementation of an information system, do a follow-up study once the systems are functioning smoothly, determine the economic value of the systems, and finally generalize the results so that cost justifications can be done without detailed economic studies in each and every case.

**BASIS:** In the resource constrained environment of the future Army, the investment in information technology will be made based upon sound economic factors. It has historically been difficult to provide solid economic justification for information systems. This project applies a new approach to measuring, improving and cost justifying white collar productivity. It is called *work profile analysis*.



When implementing information systems, these three tools (productivity measurement, cost justification and staffing analysis) fit together to help maximize the ultimate value of the system to the organization.

**APPROACH:** *Work profile analysis* involves actual measurements of the amount of time workers devote to tasks of different *intellectual levels* (e.g., management type tasks, senior professional type tasks, junior professional type tasks, technical support tasks, and so on). While the approach was developed and has been highly successful in the civilian sector, it is ideally suited to the military.

The project will bring to the military a new and powerful approach to cost justifying information systems. Based on the work profile analysis technique mentioned above, *work value analysis* is a way to calculate the implicit cost and value of different types of white collar work to the military. Because information systems change the amount, efficiency and effectiveness of white collar work, *work value analysis* is a way to attach a value to an information system based on its impact on the work environment.

The project will bring to the military an approach to analyzing *staffing requirements* on an office or departmental basis. Also based on work profile analysis, this approach determines the ideal mix of managers, professionals, administrators, clerks, etc. to get the office's work done. In the private sector, it is estimated that this technique can trim labor costs by at least 15% in the typical firm. This is because most companies are relatively understaffed at the support level and overstaffed at the senior professional and managerial levels.

**ACCOMPLISHMENTS:** This project started in September 1990.

**PLANS FOR NEXT QUARTER:** Two sites and two systems will be selected and initial data collected.

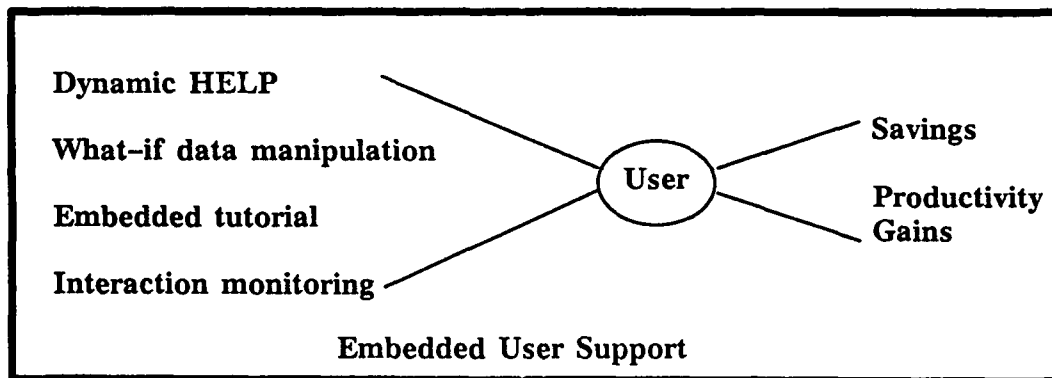
**d. TITLE: Embedded User Support**

**POC:** Major (P) Mike Mizell; (404) 894-3107

**CONTRACTOR:** Georgia Tech; Mr. Chris Smith

**OBJECTIVE:** This project will identify ways to achieve a required consistency, ease of learning, and operability by novices or occasional users of software modules. The software modules will be modified to incorporate Embedded User Support (EUS).

**BASIS:** The Installation Support Modules project will integrate modules used in daily operation of U.S. Army post, camp or station into a single environment. Without incurring the expense of totally new development, the project will bring many of the interconnections and compatibility benefits that total integration would provide.



With the consolidation of functions comes a need for better and more consistent user support. If a clerk specializes in a single function and operates only one or two software modules, great deficiencies in user interface design and user support can be tolerated and overcome. The clerk's familiarization and skill-building is refreshed daily and is amortized over thousands of performances. But the Installation Support Modules project will make it possible for one clerk to perform many functions, and for soldiers to perform some functions themselves without a clerk as a chauffeur. The expected efficiencies from the Installation Support Module project will be realized only if the software modules have user interfaces that are reasonably consistent, easy to learn, and designed for the needs of novice or intermittent users.

**APPROACH:** To achieve a required consistency, ease of learning, and operability by novices or occasional users, software modules should be

modified to incorporate Embedded User Support (EUS). The purpose of EUS features in a module is to make the module sufficiently user-friendly so that the novice or occasional user can easily answer all questions about vocabulary, interactive protocols, software capabilities, available actions, data requirements and standard expectations merely by continuing to interact with the software. The user must bring only an understanding of the underlying functional concepts of the application, ability to invoke the module, and real or artificial data or a transactional goal.

**ACCOMPLISHMENTS:** This project started in September 1990.

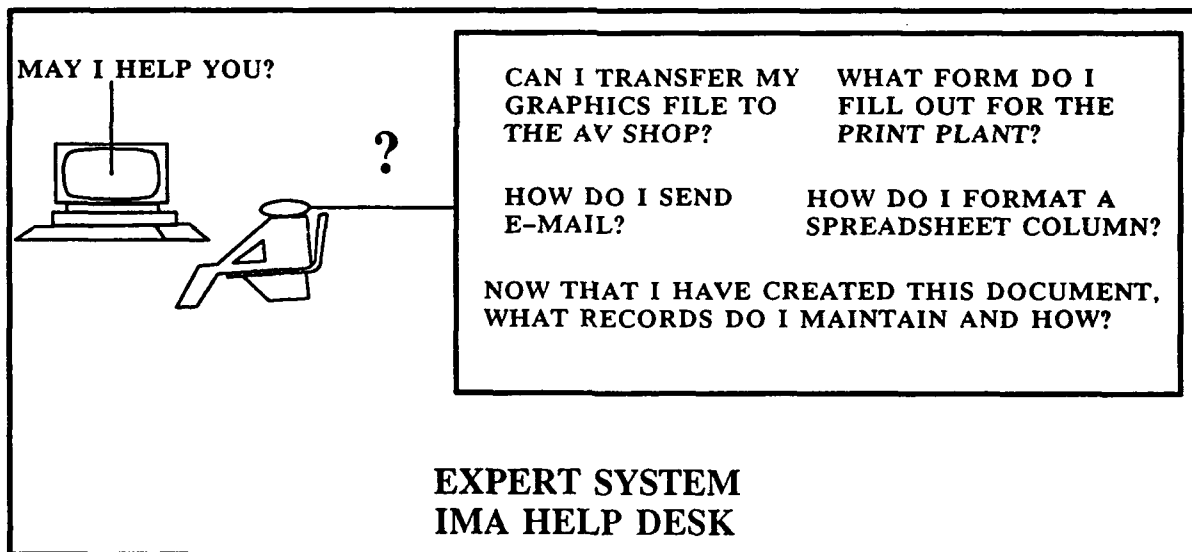
**PLANS FOR NEXT QUARTER:** Two modules will be selected for introduction of EUS techniques. Work will start on the development of EUS guidelines for use in future modules.

**e. TITLE: Information Center Tools**

POC: Dr. Michael Evans; (404) 894-3107

CONTRACTOR: In-house

**BASIS:** The Army's information needs are addressed by five information mission disciplines; areas that were once managed separately, but are now managed centrally. These five disciplines are automation, telecommunications, visual information, records management, and printing and publishing; together they are called the Information Mission Area (IMA). The IMA was formed out of the idea of Information Resource Management (IRM). The basic idea behind IRM is that information is a resource that should be managed and controlled. The IMA consists of those disciplines that are involved with the production, duplication, transmission, retention, and dissemination of information.



The Information Center (IC) is the activity that is directly related to providing end-user support for questions concerning the IMA. One of the primary functions of the IC is to provide support for end-use inquiries about the IMA. In fact, it is this function that is often perceived by the end-user as the most important function performed by the IC. This function usually goes under the name of help desk, customer support, or consulting. Some of the problems associated with providing a help desk function within the IC are: the help desk is an "on-demand" service, high turnover of help desk personnel, large volume of requests for assistance, growth of demand, and inconsistent advice.

One way to provide assistance to the IC for this very important function would be to try to automate the help desk. The main goal of the automated help desk would be to answer the most commonly asked questions directed to the IC help desk. The majority of this work consists of a few questions asked over and over. The automated help desk would classify these questions and answers so that when a user has a question, instead of calling the help desk personnel, he or she would check with the automated help desk. The potential benefit to the Army of such an automated help desk function are great. The results from this research will be directly applicable to all Army ICs.

**APPROACH:** The approach to be taken in this research is to develop an "expert system" help desk function to support the IC personnel assigned to provide this function. This research will be conducted in two phases. The first phase will concentrate on developing a prototype help desk supporting a single area of the IMA; the first prototype will provide assistance in automation support. The second phases will then attack the problem of providing support for the other four areas of the IMA. The prototype was developed in conjunction with the IC at 2nd Army which is located at Fort Gillem, GA. This research is supported by ISC-DCSPLANS, 7th Signal Command, and GPCSC.

**ACCOMPLISHMENTS:** The contract for the first phase of this research was awarded in April 1989 for a period of six months.

The contractor conducted a knowledge acquisition session in June 1989. This knowledge acquisition session used the tools developed by the University of Arizona for collaborative work.

The first prototype was completed and briefly used at the IC at Fort Gillem. Due to budget cuts the system was moved to AIRMICS for evaluation and in-house extension. Limited work was done evaluating additional approaches, such as hypertext.

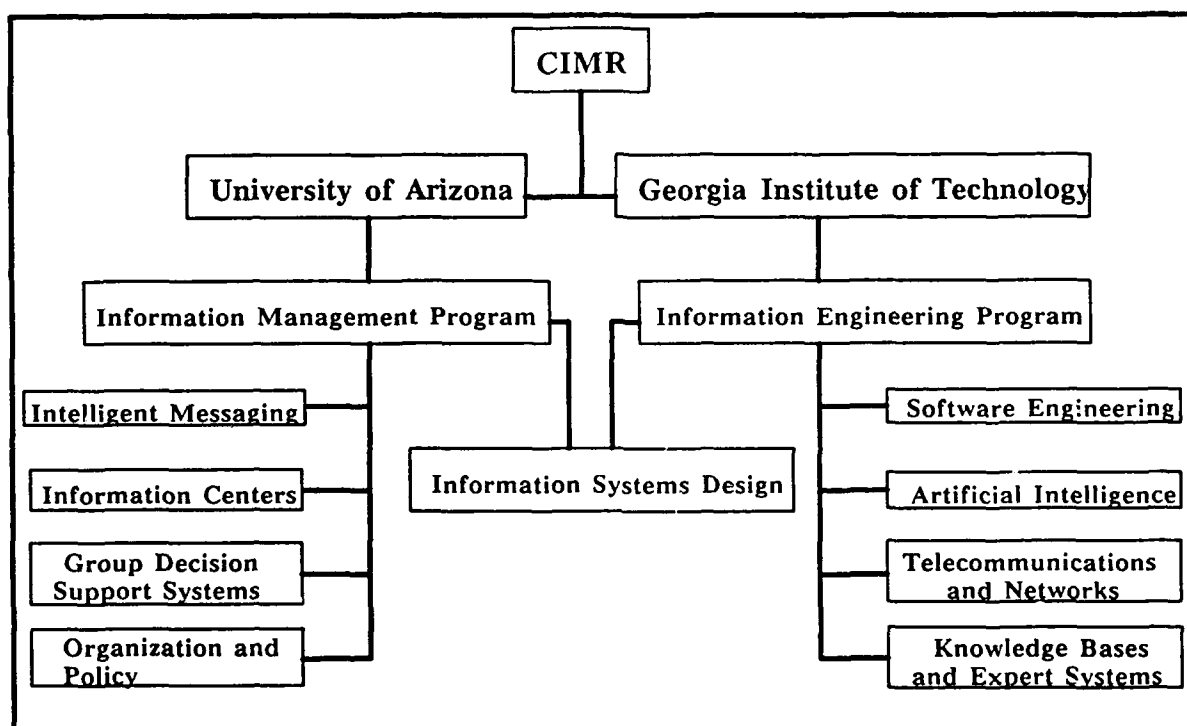
**PLANS FOR NEXT QUARTER:** The second phase of this research was delayed due to budget reductions. A new effort is planned, when funds become available, which will target the GPCSC as the customer for this type of system.

**f. TITLE: Center for Information Management Research (CIMR)**

POC: Dr. James Gantt; (404) 894-3107

CONTRACTOR: Georgia Institute of Technology; Mr. Mike McCracken  
University of Arizona; Dr. Jay Nunamaker

OBJECTIVE: Expand cooperation with University Research Centers to leverage limited research dollars and increase the ability of universities to address Information Mission Area (IMA) issues important to the Army.



**BASIS:** The expansion of the AIRMICS research mission to include the entire Information Mission Area, as assigned to ISC, has created the need to cover many new technology areas. The CIMR will link the Information Management program at the University of Arizona with the Information Engineering program at the Georgia Institute of Technology and create an Information Systems Design program. The center will focus on: (1) ways to enhance information systems support of organizational goals, objectives, and strategies, (2) promoting the development of information systems designs which focus on the resources and needs of diverse organizational environments, (3) promoting the integration of advanced information technologies with traditional information systems, (4) developing a framework for management of information systems resources which is consistent with the

organization's management system, and (5) encouraging the identification and development of a portfolio of information products and services.

**APPROACH:** CIMR is a joint University-Industry-Government research center, sponsored by the National Science Foundation (NSF) and the Army, located at the Georgia Institute of Technology and the University of Arizona. Members of the center pool limited amounts of money to execute a significant research program. By sponsoring this center as a representative for ISC and ISEC, AIRMICS is able to influence the direction of research conducted by CIMR. CIMR sponsors research that is funded by the pooled membership funds from AIRMICS, NSF and 9 corporations. The critical research areas mentioned in the BASIS are some of the topics in which CIMR conducts research.

**ACCOMPLISHMENTS:** The project on "Enterprise Analysis" will use PM ISM to collect data on the benefits of using GDSS to define requirements for information systems. Five separate sessions, covering seven weeks, have been completed by the PM and Director of Management at HQDA. The results have been well received and additional sessions are planned. Two additional corporations have become center members.

**PLANS FOR NEXT QUARTER:** The Winter Board of Directors Meeting will be held at the University of Arizona in January. Two additional requirements definition sessions are planned for the first quarter of FY91.

**g. TITLE: A Pilot Project on Campus Relations Through Teleconferencing and Systems (CARTS) for HBCUs and the Army**

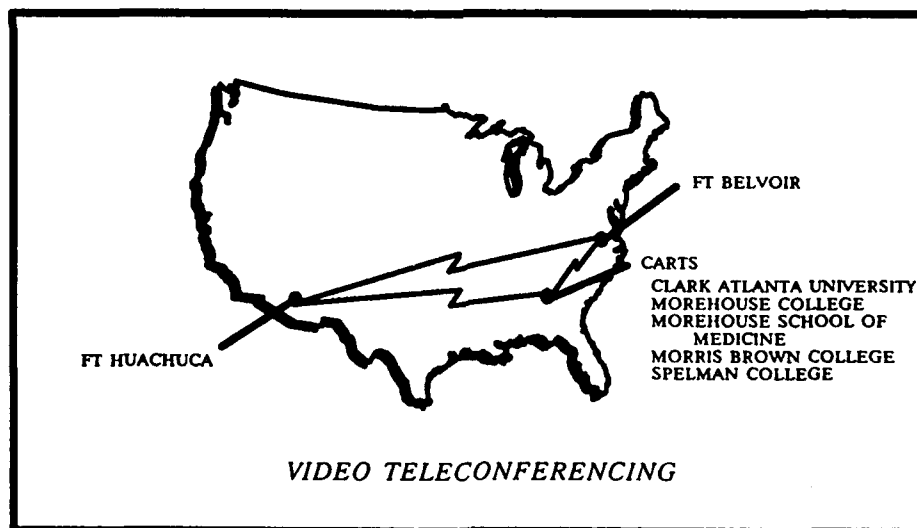
**POC:** Dr. James Gantt; (404) 894-3107

**CONTRACTOR:** Clark Atlanta University; Ms. Diane Bowles

**OBJECTIVE:** To apply video teleconferencing technology to improve campus relations between the Army and HBCUs and explore the uses, costs, and benefits of the technology to the Army.

**BASIS:** Executive Order 12320 cites the need to overcome barriers that prevent Historically Black Colleges and Universities (HBCUs) from competing for research contracts. One of the barriers is the inability to communicate with external organizations. The Army has recognized the specific need for communicating with HBCUs.

Video teleconferencing (VTC) is gaining wide acceptance within DoD and the Army. Current systems are expensive fixed-site operations. There is a need to explore how to best use VTC and to document the costs and benefits.



**APPROACH:** Communications with HBCUs will be expanded and new opportunities for campus relations can be explored. This pilot study will explore faculty development, campus relations and recruiting to provide the knowledge and understanding necessary to determine whether or not video teleconferencing and proposed computer systems are a cost effective means of meeting the needs of improved communications between HBCUs and the Army. Video teleconferencing units will be installed at Atlanta University,

Fort Belvoir, and Fort Huachuca during the pilot study. Funding for this project was provided by the ASA (RDA). Groups actively involved in this effort are ISC-DCSPLANS, ISEC-PID, ISSC, DISC4, DA SADBUE, and PERSINSCOM.

**ACCOMPLISHMENTS:** The contract with Clark Atlanta University was awarded on 19 May 1988. A coordination visit to Fort Belvoir was conducted by AIRMICS personnel to identify installation requirements (May 1988). In early June 1988, representatives from AIRMICS and Clark Atlanta University visited Fort Huachuca to identify and coordinate installation requirements.

Installation of the VTC unit at Clark Atlanta University was completed in July 1988. The VTC installation at Fort Huachuca was completed in September 1988. The VTC unit at Fort Belvoir was installed in February 1989.

Testing of the VTC unit at Fort Huachuca was completed during the first quarter of FY89. Numerous demonstrations were given to representatives of ISC, ISEC, AMC, DA, and HBCUs. Due to difficulties in obtaining approvals for installation of satellite dishes and price reductions for fiber optic lines, the VTC vendor changed from satellite communications to fiber optics.

Phase I was completed in February 1989. The option for Phase II of the contract was executed and this phase is scheduled for completion in December 1990. Phase II is designed to collect operational data for analysis of this technology. The system is being used for recruiting, staff meetings, research interactions, and project meetings.

A VTC unit has been installed at Prairie View A&M.

A new contract was awarded to Clark Atlanta University in September 1989 to expand the project to additional sites. The additional sites will allow for increase data collection and the testing of new applications. Units have been installed at PERSINSCOM, AIRMICS, and the U.S. Navy. The long distance carrier was changed to provide increased interoperability with DCTN.

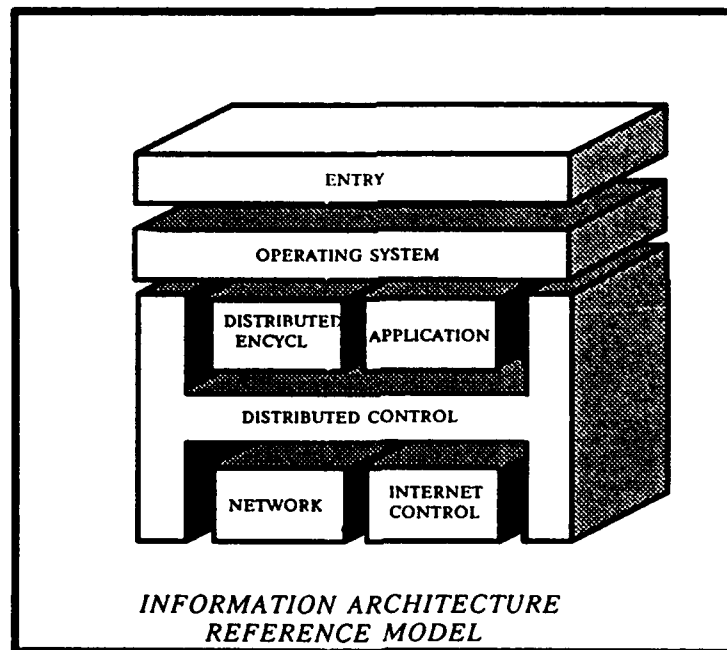
**PLANS FOR NEXT QUARTER:** Provide connectivity to the DCTN VTC network. Installation of additional units are planned at PERSINSCOM and Fort Devens.

**h. TITLE: Integration of Computer Systems In a Heterogeneous Environment**

POC: Dr. Jerry McCoyd; (404) 894-3107

CONTRACTOR: Software Engineering Research Center (SERC); Mr. William Putnam

OBJECTIVE: The objective of this project is to expand and evaluate the concept of the Information Architecture Reference Model (IARM) by integrating a set of independently developed applications into a heterogeneous environment consisting of several hardware systems, several operating systems, and several data base management systems.



BASIS: AIRMICS has proposed the Information Architecture Reference Model (IARM) to serve as a framework for the Army Information Architecture's (AIA) geographical/technical architecture. The IARM is an architectural reference model, not a design model. The architecture does not change with time and technology and provides a strategic view of how information systems work together. It depicts services provided, not the interconnection of physical components. This gives the model a great deal of flexibility which allows for rapid integration of new technology, without incurring massive physical changes. The architecture defines what the system

does and provides a unified concept to engineering, integration, research, and planning activities.

The model consists of seven distinct modules: Entry, Operating System, Application, Distributed Encyclopedia, Distributed Control, Internet Control, and Network. Although it is not a separate module, underlying the model is a facility that provides the necessary hardware and connectivity support for the model.

The model serves as a framework for specifying detailed system requirements before designing a solution to meet the overall system objectives. The IARM offers to identify and help develop standards based on known interfaces and protocols. The establishment of these standards will allow for technology upgrades to be integrated into existing systems without the wholesale replacement of hardware and software components and the burden of retraining the user work force. There will also be an increase in productivity due to forced reusability of services.

**APPROACH:** The development of the IARM framework is the first step. Additional work is needed to precisely define the specific service tasks and interfaces to be provided by each module of the model. The objective of this project is to begin the work of defining these tasks and identifying these interfaces by integrating a set of independently developed applications.

Several AIRMICS research projects: ANSWER, RAID, and IOIS, described elsewhere in this report, have reached the stage where a workable prototype is ready to be integrated into a test and evaluation environment. Another project, which analyzed the AIRMICS organization within the framework of the AIRMICS Information Architecture Reference Model (IARM) and the AIRMICS Information System Plan (ISP), identified the functions that AIRMICS personnel must perform to carry out their mission, and the knowledge worker services that must be available for AIRMICS to achieve its goals. The approach taken in this project will be to develop several of the databases identified by the ISP analysis, and integrate them along with ANSWER, RAID, and IOIS into the AIRMICS computing environment. Since these prototypes have been developed independently, and since the AIRMICS computing environment consists of four types of workstations, three different types of hardware platforms, two different operating systems, and three different data base management systems, this will provide an

opportunity for a careful analysis of the basic ideas of the IARM and for a more detailed specification of the IARM modules and their interfaces.

**ACCOMPLISHMENTS:** The contract was awarded in November 1989 to SERC, Georgia Institute of Technology, for a period of one year. Hardware and software requirements for the AIRMICS testbed were identified, acquired and installed. Functional specifications were developed during the first quarter and the design and implementation of the associated databases were completed during the fourth quarter FY90. The completion date of the contract was extended until the second quarter FY91.

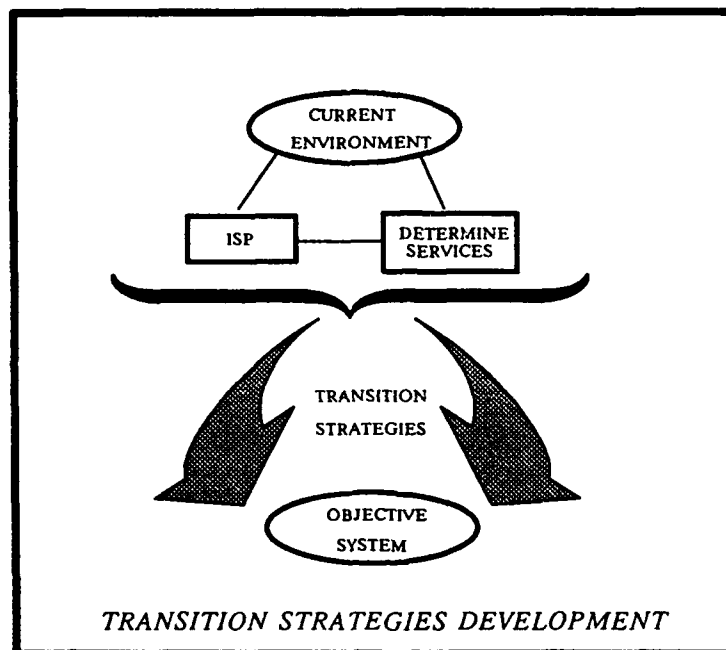
**PLANS:** Evaluate the integration effort and start preparation of the final report.

**i. TITLE: Information Technology Transition Strategies**

**POC:** Dr. Jerry McCoyd; (404) 894-3107

**CONTRACTOR:** Software Engineering Research Center (SERC); Mr. William Putnam

**OBJECTIVE:** The objective of this project is to develop information technology transition strategies to take advantage of new technology as it becomes available. These strategies will enhance the productivity of the knowledge worker.



**BASIS:** As new technologies become available, there must be established methodologies to integrate the new technology into existing systems. Currently, this is accomplished in an ad-hoc manner or by replacing entire systems; neither of these two methods are ideal. Therefore, transition strategies must be developed to insure new technologies can be smoothly integrated into existing systems. Transition strategies will provide the bridge from today's current technology to new technology. Included in the transition strategies must be methods for handling the traditional transition problems. These problems include: training, integration, productivity analysis, and justification. The developed technology transitions will result in information systems that are the most economical and productive to the Army.

**APPROACH:** The approach will be to develop transition strategies based on a test environment/organization. The test organization will undergo or use an

existing Information Systems Plan (ISP). The ISP will be used to determine the services and data used by the organization. The test ISP will be compared to other ISP-like methodologies to determine the best method for determining data and process usage in an organization. The ISP will be the base document for determining the services required by the test organization. The required services will establish the type hardware configuration and required software. The final hardware and software configuration will be the testbed for the transition work. The final part of this task will be to determine the productivity gains, if any, by using the ISP method to derive information services.

**ACCOMPLISHMENTS:** The contract was awarded on 5 March 1988 to SERC, Georgia Institute of Technology, for a period of one year. During the initial meeting, it was decided to use AIRMICS as the test organization.

The first of five tasks of this project was completed in May 1988. A test ISP of AIRMICS was completed. The ISP identifies the processes and data used by AIRMICS. Additionally, each major process was decomposed to show the logical information flow of data between sub-processes.

The ISP and analysis provided the initial identification of the software and hardware required for the transition testbed.

A set of interim services, based on the ISP have been established. A number of vendors have been contacted to provide demonstration copies of software or information on their products. These interim solutions are being evaluated.

The initial hardware items, to include a central server, have been ordered or placed on order by the contractor. The items selected were based on the ISP requirements.

An initial testbed for the AIRMICS environment has been established. The testbed uses an Ethernet to link workstations, PCs, and terminals into an integrated environment. The Initial Service Study for the AIRMICS environment has been completed. The base-level services have been incorporated into the testbed. These services provide the initial foundation for integrated services.

**PLANS FOR THE NEXT QUARTER:** The project was completed during the first quarter FY90.

PUBLISHED REPORT:

Harris, W. and Putnam, W., "Knowledge Worker Services for the Army Institute for Research in Management Information, Communications, and Computer Sciences (AIRMICS)," Software Engineering Research Center, Georgia Institute of Technology, February 1989.

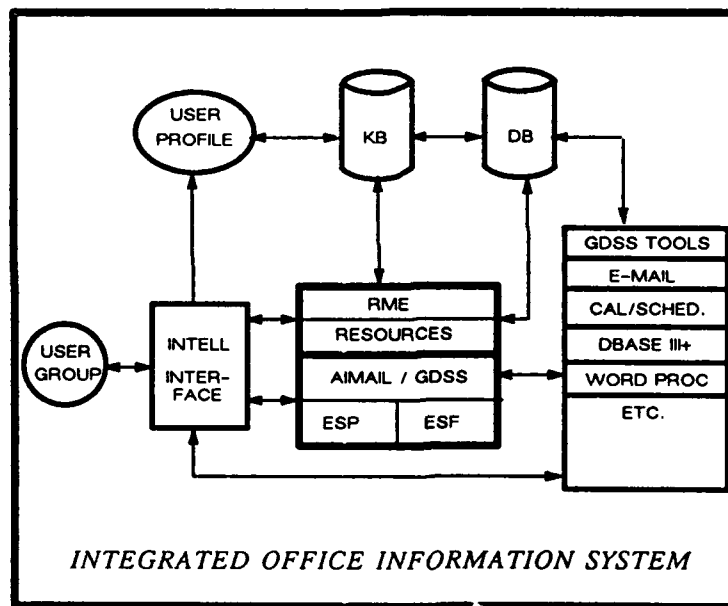
This paper provides a cross-reference of those generic services required in a knowledge worker environment. Specifically, the services required in the AIRMICS environment are addressed. These services will assist in evaluating products to be implemented on the AIRMICS testbed.

j. TITLE: Office 2000

POC: Dr. Michael Evans; (404) 894-3107

CONTRACTOR: University of Arizona; Dr. Jay Nunamaker

OBJECTIVE: The objective of this project is to design a prototype integrated office information system. The integrated office information system design will provide an implementation framework for future automated office information systems. An integrated office information system will support a variety of end users, a multitude of tasks, control information storage and access, provide as much automation of routine tasks as possible, provide a number of different tools, and be flexible enough to accommodate present and future needs.



BASIS: As increasing numbers of distributed information systems are developed, there must be an accompanying framework. Currently, new technologies are developed for the office, but they are unable to be incorporated into the existing office environment. This project will create an intelligent office environment that will allow for the integration of new technology as it becomes available without an extensive overhaul or destruction of the system. This type of office system will also reduce the amount of time and effort required in training personnel to operate new systems.

**APPROACH:** The approach used in this task will be to identify new technologies and develop strategies for implementing the technology on existing office information systems. A prototype software system will be developed at the University of Arizona. The prototype software will then be loaded onto an existing Army office system at AIRMICS. This system will be studied for productivity increases and ease of technology insertion. The information gained from this project will be transferred to other office systems within the Army in order to increase office worker productivity and ease the transition of new technology into the office environment.

**ACCOMPLISHMENTS:** A contract was awarded to the University of Arizona, Department of Management Information Systems, on 9 May 1988 for a period of one year. Initial discussions have been conducted concerning the office environment. The AIRMICS Sun workstation/UNIX with PC-AT on a Ethernet LAN has been selected as the test environment.

A detailed information flow has been completed. The information flow diagrams will be the basis for the detailed design and software coding efforts.

The development environment for the project was determined. The development team will be using the NExpert software package as an integration tool on a UNIX-based platform.

The hardware platform for the development environment has been received. The initial prototype was completed and coding was started on several of the tools. The NExpert shell is being used for the integration environment. Several of the rule sets for the selection of the tools have been tested.

A group work support systems conference was held at the University of Arizona in May. This conference, which was sponsored by AIRMICS, DSMC, and the University of Arizona, gathered individuals from industry, academia, and the military to discuss group work support systems. Group work support systems will be a dominant force in the office of the future; and, therefore early identification of the problems with group work will influence the design of the office information system. A number of tools were demonstrated during the May IPR.

This contract was completed in June 1989. Another contract started in July 1989 which extended this research with primary emphasis on group and team support.

Work on porting the GDSS tools from the MS-DOS environment to the UNIX environment was completed and demonstrated.

PLANS FOR NEXT QUARTER: This project was completed in May 1990.

#### PUBLISHED REPORTS:

1. Morrison, J., "IOIS Summary Report: An Object-Oriented SEM Design/Maintenance Methodology for an Integrated Knowledge Base/Database," University of Arizona, July 1990.

The purpose of this paper is to demonstrate a prototype of an intelligent database that explores object-oriented database and knowledge base design within a dynamic query environment. This prototype, call PATHFINDER, allows users with little system or database knowledge to access all possible combinations of database information easily and quickly. PATHFINDER's KB is easily modified to reflect changes in the database schema. This paper provides a brief review of intelligent database theory and previous intelligent database systems, followed by a description of PATHFINDER's architecture, design and implementation.

2. Sheng, O., "IOIS Summary Report: Integration Strategy for Distributed Environment," University of Arizona, July 1990.

In this paper, the Structured Object Model (SOM) is used as the backbone data model throughout the logical DB schema integration process. SOM also represents the global schema when the integration process is completed. This paper describes the SOM-based integration overview first. Then the notion of SOM is introduced, followed by a discussion of SOM-based DB schema integration phases. Examples of schema integration using SOM are described at the end.

3. Nunamaker, J., "IOIS Summary Report: Automated Session Manager Analysis, Design, and Implementation," University of Arizona, July 1990.

The purpose of this report is to detail the development of the Automated Session Manager (ASM) subsystem, which supports the Group Decision Support process. The ASM was developed to facilitate meetings of organization group members working in distributed offices. ASM facilitates the use of a suite of group support tools known as the Asynchronous Group

Decision Support System (AGDSS). The architecture of ASM consists of expert systems for pre-session planning, session facilitation, and post-session analysis, as well as group status, calendar scheduling, and data integration facilities. This report presents a detailed summary of research efforts involved in the design and implementation of these features.

4. Aiken, M., "ESP: A Consultation System for EMS Pre-Session Planning," University of Arizona, July 1990.

This paper presents a background of the problems supporting Electronic Meeting Systems (EMS) and then outlines a detailed description of the architecture of the Expert Session Planner (ESP).

5. Aiken, M., "Integration Expert Systems with Group Decision Support Systems," University of Arizona, July 1990.

Expert systems are powerful tools serving as adjuncts to decision making and have found wide applicability in a variety of areas. Synthesizing expert systems with group decision support systems has the potential to enhance the quality and efficiency of group communication, negotiation, and collaborative work. This paper examines possible synergies between the two technologies and provides a survey of the current partially-integrated systems. Finally, a prototype design of a highly-integrated system is described with directions for future research.

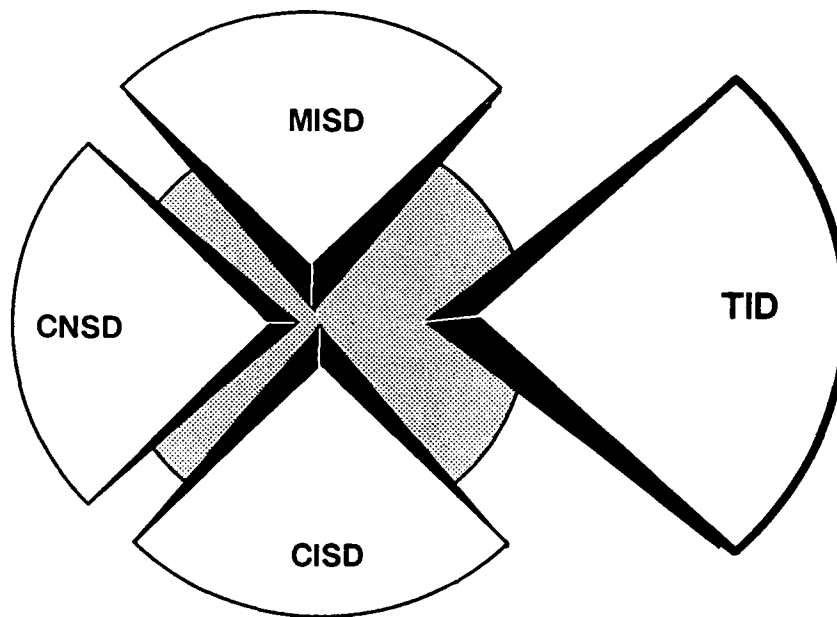
6. Morrison, J., "Application of Knowledge-Based System Design to the Design of a Distributed Group Decision Support System," University of Arizona, July 1990.

Descriptions of common software processes and requirements and design specification methods are presented to derive conclusions about their strengths, weaknesses, and domains. An attempt is made to overcome some of these problems by applying an engineering design process known as Knowledge Based System Design to the software process. This methodology is described, and an adaptation suitable for software design is developed. The resulting process is then illustrated by applying it to a software project that involves building a software system to support group decision making in a distributed environment.

## E. TECHNOLOGY INSERTION DIVISION (TID)

The Technology Insertion Division is AIRMICS' newest element. It provides a conduit for improving the flow of technology between the Army and industry, academia, and other government agencies.

Bringing innovation to the Information Systems Engineering Command (ISEC) and the Army is not new to AIRMICS. AIRMICS' research in group decision support is currently being used by the Army for acquisition activities and our pioneering efforts in installation level information centers served as the foundation of the Information Centers found on Army Installations in CONUS. TID works to reduce the risks associated with software development and deployment by using our knowledge and working with Army agencies on standard computer-aided software engineering environments, software metrics, and operational readiness indicators for software applications.



To leverage our program, AIRMICS reviews industry independent research and development projects (IR&D) and participates in jointly funded research centers. Last year, AIRMICS reviewed over 1650 project plans from forty companies. In these reviews, over 80 IMA-related projects were identified. AIRMICS participates at NSF initiated Industry-University cooperative research centers such as the Center for Telecommunications Research Center at Columbia University, Center for Information Management at Georgia Institute of Technology and University of Arizona, and the Software

Engineering Research Center at Purdue University and the University of Florida. Through these activities, AIRMICS maintains a vigilant watch of important research areas to capitalize on research results from industry and academia.

TID has been sponsoring the use of the SEI's Software Engineering Self-Assessment Process at the Software Development Centers (SDCs) of the Information Systems Software Center (ISSC) throughout the past year. This project continues into the new fiscal year with the development of an ISSC corporate assessment based on the combination of the individual SDC assessments.

TID also represents ISC and ISEC on the Advisory Board for the Annual Conference on Ada Technology (ANCOAT). The 9th ANCOAT will be held in Washington, DC in March 1991. This year, of the 48 abstracts accepted for presentation, six were from ISEC or contractors doing work for ISEC.

TID has been heavily participating in the Software Test and Evaluation Panel sponsored by OTEA. This project is an outgrowth of a 1983-1987 DOD project of the same purpose in which AIRMICS was a significant contributor. The current project has resulted in initiatives to streamline the regulations involved in the production and test of software and the establishment of a preliminary set of measures to be taken in software projects throughout the Army.

TID's main effort is bringing technology to the Army from industry and academia. A new task is "Domestic Technology Transfer" involving the transfer of technology to private industry and the co-development of technology with industry through Cooperative Research and Development Agreements. AIRMICS began this work as a result of joining the Federal Laboratory Consortium near the end of fiscal year 1990. With this opportunity, TID will develop win-win situations between the Army and industry. The government will get unlimited use of new products and our industry partners will commercially exploit these developments.

If you are interested in any of the above areas discussed in this Research Status Report, or have questions relating to TID, please contact LTC Blake or Mr. Hocking, e-mail address [blake%airmics@gatech.edu](mailto:blake%airmics@gatech.edu) or [hocking%airmics@gatech.edu](mailto:hocking%airmics@gatech.edu), phone (404) 894-3104 or 894-3110, respectively.

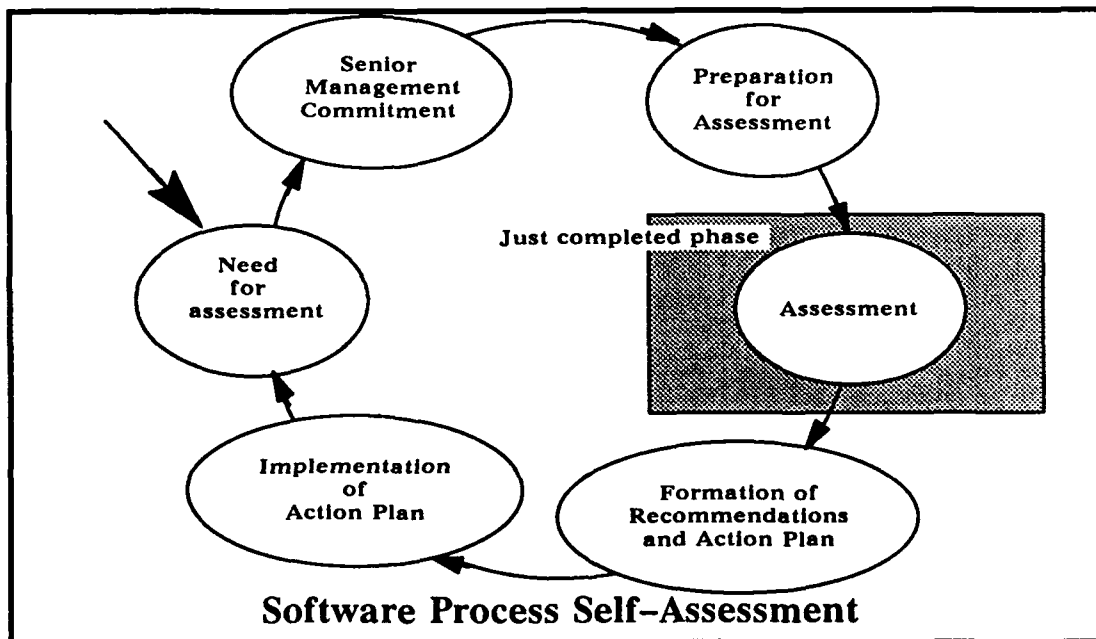
## 1. TECHNOLOGY TRANSFER WITHIN ARMY

### a. TITLE: Use of the SEI Self-Assessment Process

POC: Mr. Daniel E. Hocking; (404) 894-3110

CONTRACTOR: In-house (assisted by ISSC and the SEI)

OBJECTIVE: The objective of the self-assessment is to identify the maturity level of the software process within the Software Development Centers (SDCs) and where to most effectively apply resources to improve the software engineering process within each SDC and within ISSC as a whole. AIRMICS' objective goes beyond this to identify research topics most relevant to needs within ISSC.



BASIS: The SEI developed the method for software process assessment. The SEI project provides the Defense Department with a way to characterize the capabilities of software development organizations. The result is a software process maturity framework. It can be used by any software organization to assess its capabilities and identify the most effective areas for improvement. The criteria for an ideal software process is that the process be predictable in both cost and schedule and the quality of the resulting products generally meets user needs.

To improve the organization's software capabilities, the organization must:  
(1) understand the current status of the organization's development process,

(2) develop a vision of the desired process, (3) establish a list of required process improvement actions in order of priority, (4) produce a plan to accomplish these actions, and (5) commit the resources to execute the plan.

Early results from use of the SEI model indicate that it reasonably represents the state of such organizations and provides a mechanism to rapidly identify the key improvement issues they face.

**APPROACH:** We took advantage of the SEI assessment program which focuses on improving the process of software development. A self-assessment team, consisting of ISSC personnel and a representative from AIRMICS, formed and received training in September 1989 at the SEI. This year the team conducted self-assessments of ISSC's Software Development Centers and is putting together a set of findings.

AIRMICS funded most of the TDY costs for training the assessment team and initial assessments of SDC-W, SDC-L, SDC-B, and SDC-H and the overall corporate ISSC findings briefing and report. This will help the SDCs focus their needs for process improvement. This will also help AIRMICS focus the technology insertion tasks and establish a foundation for sustained improvement of software capabilities. This will help establish and maintain the capacity to support systems delivered by ISEC contractors. AIRMICS also gains a more comprehensive perspective of ISEC software engineering needs which will aid in the conduct of R&D for software engineering.

**ACCOMPLISHMENTS:** The initial training and four SDC assessments have been completed through the findings briefing and findings reports. They were delivered to the respective commanders. The commanders of the SDCs may release the self-assessment results at their discretion.

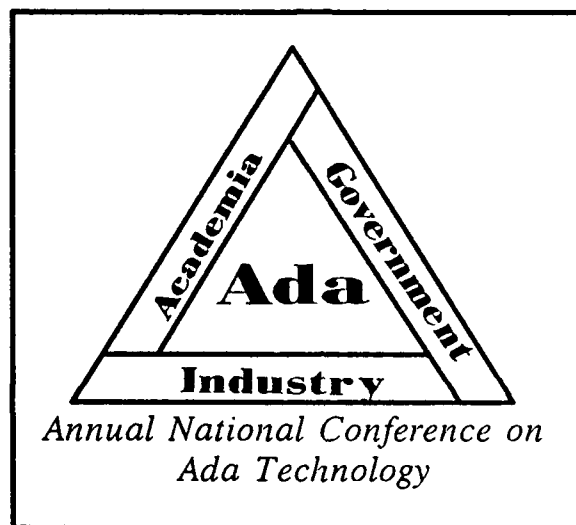
**PLANS FOR NEXT QUARTER:** The individual SDC assessments will be combined into a corporate assesment. The assessment team will meet 15-19 October 1990, prepare the corporate findings briefing, and present that briefing to the Commander of ISSC. Then the final corporate findings report will be completed.

**b. TITLE: Ninth Annual National Conference on Ada Technology (9th ANCOAT)**

POC: Mr. Daniel E. Hocking; (404) 894-3110

CONTRACTOR: In-house

OBJECTIVE: To promote the use of Ada within government agencies (particularly the DOD), industry, and academia (with emphasis on historically black colleges and universities (HBCUs)) and to provide a forum for lessons learned, technology exchange, problems and solutions in working with Ada.



BASIS: Exchange of technical information is needed among the government agencies (particularly the military services), industry, and academia to determine state-of-the-art with respect to system development and enhanced capabilities to support interoperability among tactical and sustaining base systems through the use of Ada. By having a conference where Ada practitioners can discuss research and development activities, ISEC leverages limited resources to the maximum extent. For example, lessons learned throughout the Ada software development community can be shared with members of ISEC, hopefully reducing the risk of ISEC development projects repeating the same mistakes. Newly developed tools and techniques can be discussed and brought into ISEC, thereby reducing costs. Of course, this requires that ISEC members contribute and share their problems as well as successes.

APPROACH: An early and continuing emphasis of the conference has been on improving Ada expertise and on transferring the associated technologies to

historically black colleges and universities. The conference is managed by a committee consisting of representatives from up to twenty-five companies and universities plus representatives from the sponsoring government organizations. The Communications and Electronics Command was the initial sponsor and was joined by AIRMICS for the conferences held in 1987 and 1988 in Washington, DC. Sponsorship has been expanded to include the other services, and for 1989, NASA, the Department of Commerce, and Federal Aviation Administration. The 1990 conference was held in Atlanta.

**ACCOMPLISHMENTS:** For the 1991 Conference, a call for papers inviting 300-word abstracts of research papers on topics including the use of Ada, Ada Education and Training, Life Cycle Issues, Environments, Productivity, Project Management, and Technology Research was issued with a 10 August 1990 deadline for submission of abstracts. Sixty-seven abstracts were received of which forty-eight were accepted for publication. ISEC is represented by six papers. Of particular interest to ISEC attendees will be the sessions on Metrics and Reuse.

A preliminary program was mailed in July 1990. The sessions titles are: Management; Metrics; Reuse; Technology Research; Education; Environments; Process and Methods; and Real Time Systems.

**PLANS FOR THE NEXT QUARTER:** A Conference Board Meeting will be held in November 1990. The conference will be held 4 March 1991 at the Washington Hilton and Towers, Washington, DC with one day of tutorials followed by three days of technical report sessions.

**c. TITLE: Software Test and Evaluation Panel**

POC: LTC Jim Blake; (404) 894-3110

CONTRACTOR: In-house

**OBJECTIVES:** The Software Test and Evaluation Panel (STEP) has three objectives: (1) to develop a better approach to performing software test and evaluation (T&E), (2) to develop a methodology to assess the readiness of software for technical and operational testing, and (3) to develop methods for determining the impact of software deficiencies on overall system effectiveness and suitability for fielding.

**BASIS:** The number of systems failing operational testing as a result of immature software has been increasing at an alarming rate. The costs, in terms of money, time, and public confidence in our weapons systems, has exceeded all reasonable thresholds. The Army must identify those weapons systems with software problems before they reach operational testing.

**APPROACH:** In September 1989, the STEP was formed at the request of the Commander of the Operational and Test and Evaluation Agency (OTEA). The STEP reports to the Deputy Under Secretary of the Army for Operations Research (DUSA(OR)) and consists of Army representatives from software testing and software development organizations. The STEP Chair is the Technical Director of OTEA. AIRMICS participated in the STEP as an affiliate member.

The basic approach to accomplishing the stated objectives was to form six subgroups to attack parts of the problem and then to hold periodic meetings to review subgroup progress and issue additional tasking. AIRMICS was a member of the T&E Techniques and Practices Subgroup; and, at the request of the STEP Chair, provided assistance to the Measures and Standards and Regulations Subgroups.

**ACCOMPLISHMENTS:** AIRMICS contributions to the STEP are illustrated by our support to the Standards and Regulations Subgroup (SRS). In spite of extensive searching in the Pentagon, they were unable to obtain many of the software-related T&E publications needed for their research. They had compiled a list of 267 documents relating to Software Test and Evaluation but

were able to obtain only a small percentage of these publications from the Pentagon publications center. AIRMICS used its resources and those at Georgia Tech to put together a list of distributors of DOD-related publications organized by the categories of documents needed for the STEP requirement. This list included all information necessary to obtain copies of the documents. AIRMICS also contacted the major distributors of DOD or DA publications to determine the availability of online databases with full text retrieval capabilities. This information, along with cost estimates for obtaining the documents from the Georgia Tech Information Center, was forwarded to DISC4, the SRS Chair.

Over the twelve months since the STEP was formed, significant progress has been made toward accomplishing the stated objectives. In May 90, the Vice Chief of Staff of the Army (VCSA) and DUSA(OR) were briefed on the STEP's findings and recommendations. The VCSA approved the three STEP recommendations and provided funding to implement them. The three actions are: (1) Implement Requirements Definition Documents to increase user input early in the development process, (2) Require the collection of software metrics and provide centralized oversight of these metrics Army-wide, and (3) Align and consolidate Standards and Regulations which apply to Software T&E and make a standardized testing process.

The STEP appointed implementation teams to accomplish these actions and work by these teams was begun shortly after this decision. Progress on these actions will be reported to the VCSA and DUSA(OR) in mid-FY91.

**PLANS FOR THE NEXT QUARTER:** The next general STEP meeting is scheduled for late November, and a review of the schedules and milestones for each implementation team will be reviewed.

## 2. DOMESTIC TECHNOLOGY TRANSFER

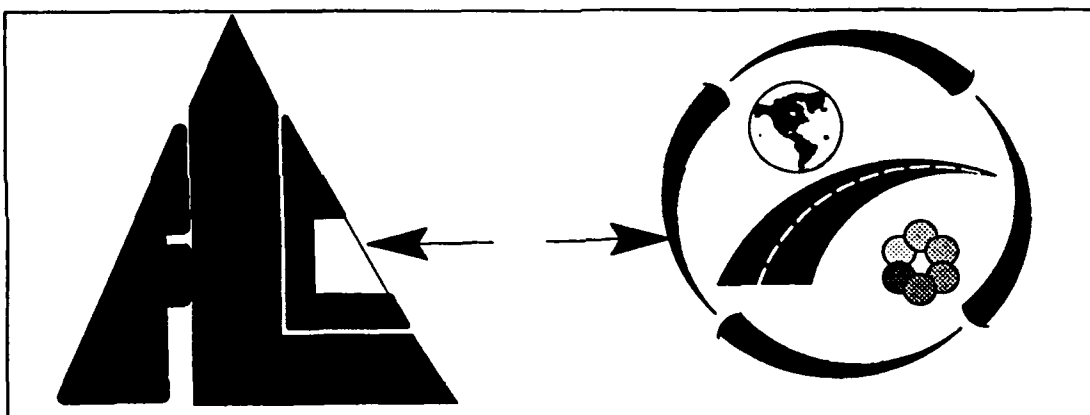
**TITLE:** Membership in the Federal Laboratory Consortium

**POC:** Daniel E. Hocking; (404) 894-3110

**CONTRACTOR:** In-house

**OBJECTIVE:** Membership in the Federal Laboratory Consortium gives AIRMICS an opportunity to work with all the Federal laboratories to promote "Domestic Technology Transfer." The principal goal is to enhance domestic companies' industrial competitiveness.

**BASIS:** "Domestic Technology Transfer" is a program mandated by the Stevenson-Wydler Act of 1986. This is yet one more way in which AIRMICS can leverage research dollars to amplify the work done for ISC organizations by identifying work done at other laboratories which may be useful within the IMA.



**APPROACH:** The approach is to participate in the Federal Laboratory Consortium activities within the limits designated by the enabling legislation and AIRMICS budget. We will establish generic Cooperative Research and Development Agreements (CRDA) to promote technology development for commercial purposes as a prelude to establishing specific CRDAs with one or more companies.

**ACCOMPLISHMENTS:** Participation in this program has just begun.

**PLANS FOR NEXT QUARTER:** AIRMICS will participate in the next Federal Laboratories Consortium meeting in New Orleans, 12-15 November 1990. AIRMICS will also develop a draft Cooperative Research and Development Agreement based on samples received from the Department of Energy.

**F. UPCOMING EVENTS - 1 October 1990 through 31 January 1991**

<b>Day</b>	<b>Month</b>	<b>Event</b>
31	October	Center for Telecommunications Research Annual Program Review, Columbia University, NY.
1	November	DoD Software Technology Plan Working Group Meeting, IDA, Alexandria, VA.
5-6	November	Executive Course, "Software: Profit Through Process Improvement," SEI, Pittsburgh, PA.
7-9	November	IEEE Workshop on the Management of Replicated Data, Houston, TX.
14-16	November	Software Engineering Research Center (SERC) Advisory Board Meeting at the Univ. of Florida, Gainesville, FL.
28	November	IPR for the Application of Neural Networks for the Extraction and Characterization of Knowledge Contained in Databases, Atlanta, GA.
28-29	November	Fifteenth Annual Software Engineering Workshop, NASA Goddard Space Flight Center, Greenbelt, MD.
3-5	December	ACM SIGSoft 90, Fourth Symposium on Software Development Environments, Irvine, CA.
3-7	December	Tri-Ada 90, Baltimore, MD.
	December	Final IPR on AAMS, Washington, DC.
16-18	January	International Workshop on Unix-Based Software Development Environments, Dallas, TX.
	January	Winter Board meeting of the Center for Information Management Research (CIMR), University of Arizona, Tucson, AZ.

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AAE, Army Acquisition Executive, 72

AAMS, Army Acquisition Management System, 65, 72

ACE, Application Connectivity Environment, 82

ACTS, Advanced Communications Technology Satellite, ISDN experiment, 36

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AUTOVON, Automatic Voice Network, 60

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